THE WEATHER AND CIRCULATION OF SEPTEMBER 1958[1]

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1. WEATHER HIGHLIGHTS

Local Climatological Data from Columbus, Ga., for the month of September 1958 included the following remark: "September brought nothing outstanding in the way of weather phenomena." Similar remarks could be made this September in many cities across the United States. The only sizable temperature departures from normal were along the California coast, where temperatures averaged as much as 8° F. above normal.

As is often the case in September, newspaper headlines were generated by the fury of typhoons and hurricanes. At least three severe typhoons occurred during the month: Grace, Helen, and Ida (fig. 1A). Typhoon Ida was attended by gusts of 175 m. p. h. before it crossed the Tokyo-Yokohama area on September 26 with winds in excess of 80 m. p. h. Serious flooding was associated with this typhoon, the worst to strike Japan in 24 years. More than 20 inches of rain fell on 4,300-foot Mount Amagi and the rushing waters of the swollen Kano River destroyed two villages on the Izu Peninsula, 70 miles south of Tokyo, sweeping people into the bay. The incomplete casualty toll includes 340 dead, 984 missing, and more than half a million people made homeless.

North America was also affected by tropical storm activity. Hurricane Helene (fig. 1B) was the biggest threat to the east coast of the United States since 1955. After feinting at the South Carolina coastal cities, Helene pursued a northward course along the Carolina coast, always keeping the center of its eye just offshore (approaching within 10 miles off Cape Lookout, N. C.). Record wind speeds were reported at many stations in the Carolinas, as gusts of 135 m. p. h. were experienced at Wilmington and 144 m. p. h. at Cape Lookout. Despite $11 million damages, largely as a result of the wind, there was no loss of life in the Carolinas. After Helene moved northward off the east coast of the United States, high tides, heavy seas, strong winds, and drenching rain caused damage in the Canadian Maritime Provinces.

Nature fashioned another headline in Texas where heavy to excessive rains fell in the western portion of the State and in the mountain areas of northern Mexico. This rainfall over the Rio Conchos River watershed produced the highest stage in 32 years on the Rio Grande River at Presidio, Tex. On September 28 the river crested at 21 ft.; flood stage is 10 ft. Heavy damage to farmlands resulted.

[1] See Charts I-XVII following p. 376 for analyzed climatological data for the month.

These weather highlights were not isolated phenomena and can be related to the large-scale atmospheric circulation.

2. THE CIRCULATION AND THE WEATHER

THE GENERAL CIRCULATION

The mean circulation for September was characterized by high index from the coast of Asia eastward to the British Isles (figs. 2 and 3). A strong block developed over Scandinavia late in August resulting in 700-mb. heights averaging 270 ft. above normal there in September. Downstream, an anomaly center of −370 ft. appeared at 700 mb. associated with a deep trough in the lee of the Urals. These two large anomaly centers effected a large change in the circulation over Europe and Asia where it had been weak and flat in August [17]. A weak block over Kamchatka in August continued in September.

The height anomalies in the Pacific and over the United States were all rather small. Those over the United States and western Atlantic exhibited great persistence from August to September as did the average September weather of the United States, after the July–August reversal described by Woffinden [17]. The strong block that was in extreme northern Canada in August moved southeastward and diminished in intensity. A negative anomaly center that seemed to be coupled to the block on the Asiatic side of the pole appeared over the pole during September and also weakened. Heights were 330 ft. below normal west of the British Isles as several cyclonic vortices remained anchored there for days at a time, attended by gales over a large area.

PRECIPITATION

Precipitation for the month averaged considerably above normal in an area stretching eastward from Arizona through New Mexico and Texas into Louisiana, Mississippi, and Alabama and thence northward into western Tennessee, Arkansas, and Missouri (Chart III). Figure 2 shows cyclonically curved anomalous flow from the south as the average condition during September in an area from Arizona eastward to Alabama. A similar circulation prevailed at sea level (Chart XI and inset). Such a flow favors advection of Gulf moisture into this region and encourages precipitation. Part of the extensive precipitation along the Gulf Coast and also in inland Texas can be traced to the remnants of hurricane Ella which advected moisture into that area (table 1). Further

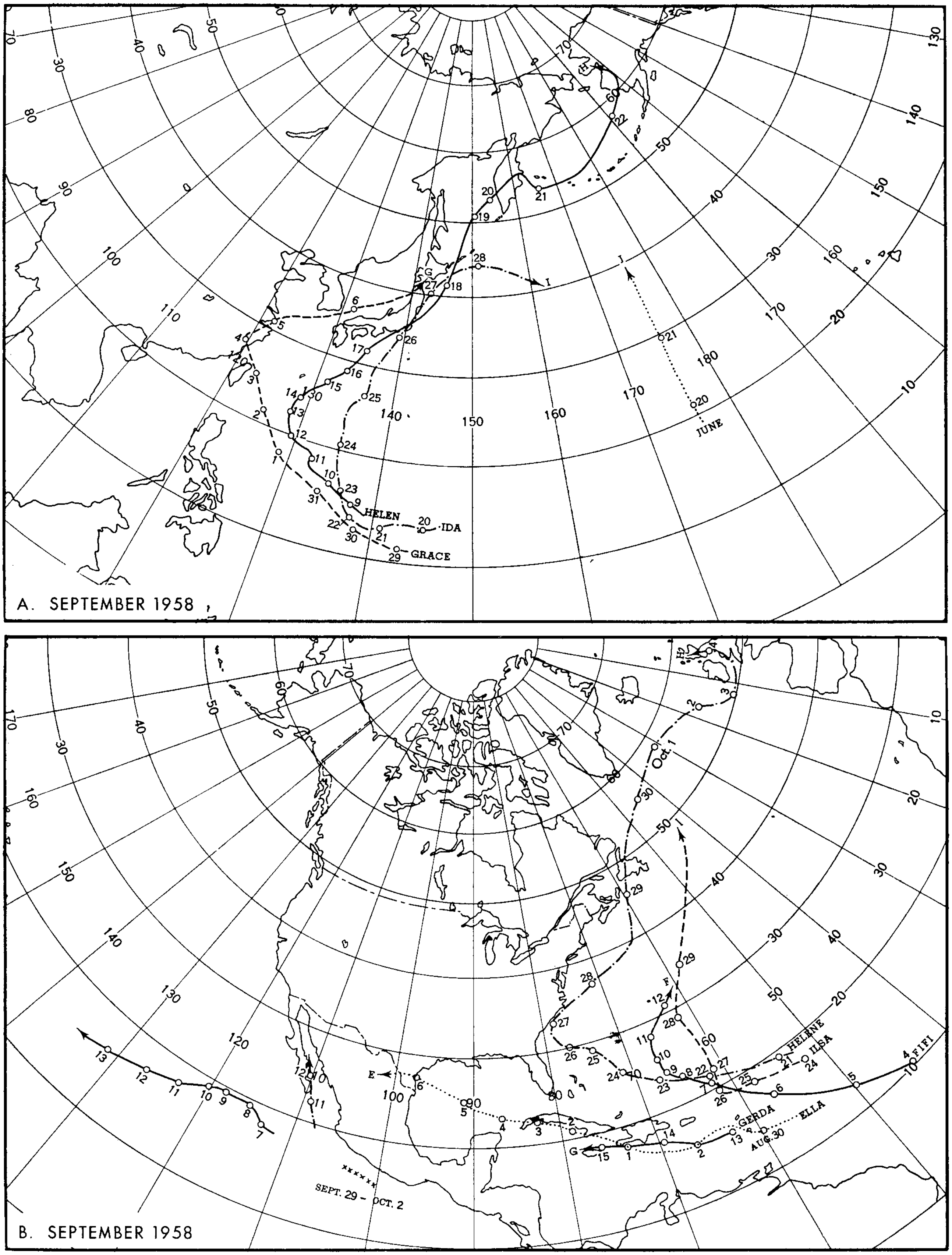

FIGURE 1.—Tropical storm tracks for September 1958, based on preliminary data. Open circles indicate 1200 GMT positions on dates given. (A) Western Pacific, (B) Atlantic and eastern Pacific.

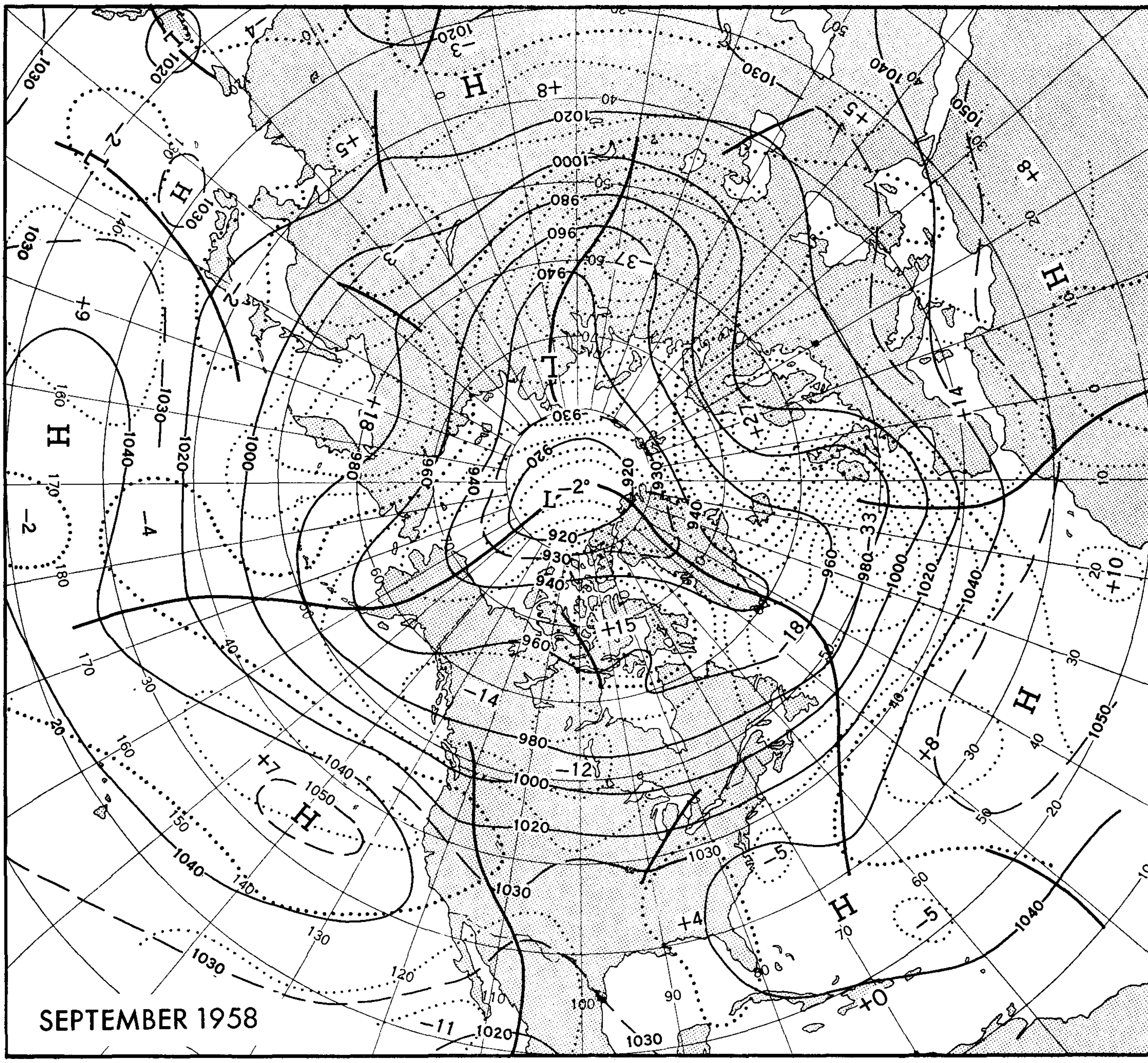

FIGURE 2.—Mean 700-mb. contours (solid) and height departures from normal (dotted), both in tens of feet, for September 1958. Troughs are indicated by heavy vertical lines. Note fast westerly flow from the coast of Asia eastward to the British Isles.

heavy precipitation occurred in Texas associated with a weak tropical depression in that area on the 19th and 20th. The heavy rainfall in western Texas caused flooding during the month. Precipitation in the Missouri-Arkansas region was largely frontal in nature.

Other heavier than normal rainfall amounts occurred in Pennsylvania and southern New England, largely the result of one storm on the 19th to the 21st (Chart X) which is discussed fully in an adjoining article [13]. Rain was also copious along the California-Nevada-Oregon border, caused by two influxes of Pacific air, the first about the 7th to the 8th, and the second from the 22d to the 23d.

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TABLE 1.—*Rainfall amounts associated with hurricane Ella 1958 and the percentage they represented of the total September rainfall at various stations in Texas*

Stations	Amount (inches)	Percentage of monthly rainfall
Austin	2.66	39
Corpus Christi	3.67	44
Galveston (city office)	6.94	50
Galveston (airport)	13.98	56
Houston (airport)	7.04	46
Laredo	1.41	30
Port Arthur	3.78	26
San Antonio	1.85	22
Victoria	3.24	24
Waco	1.39	30

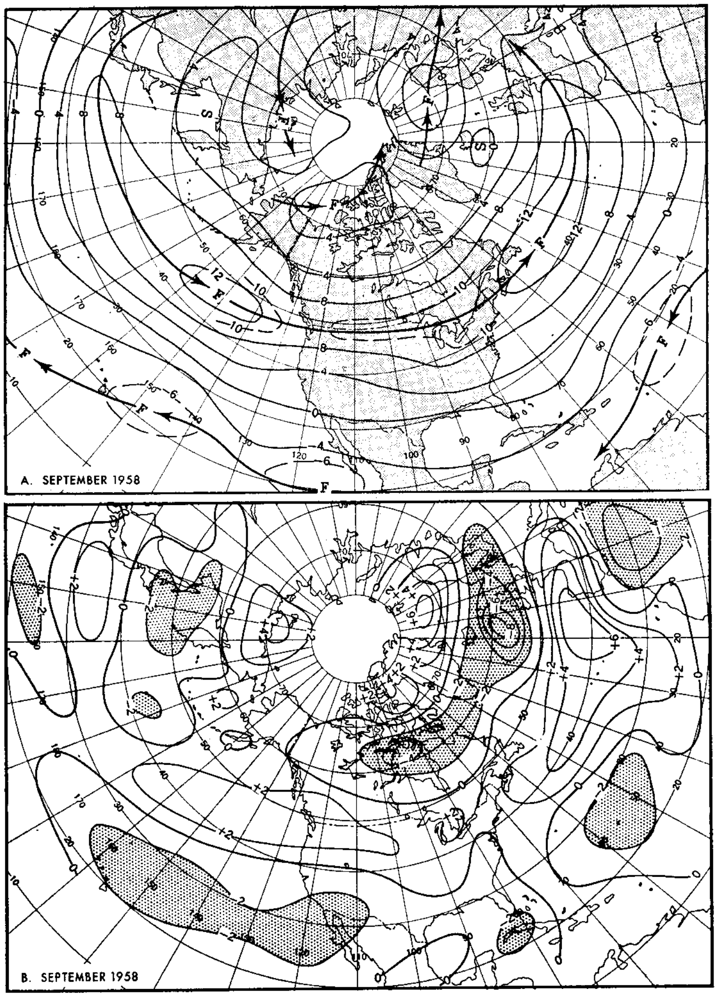

FIGURE 3.—Mean 700-mb. isotachs of the zonal wind speed component (A) and its departure from normal (B), both in meters per second for the month of September 1958. Solid arrows in (A) indicate positions of the mean axes of the 700-mb. zonal wind maximum. Westerly flow is considered positive and easterly flow negative. The hatched shading in (B) delineates areas where the departure from normal zonal flow equalled or exceeded 2 meters per second from the east. Many of the tropical storms formed in the vicinity of the easterly jet (A).

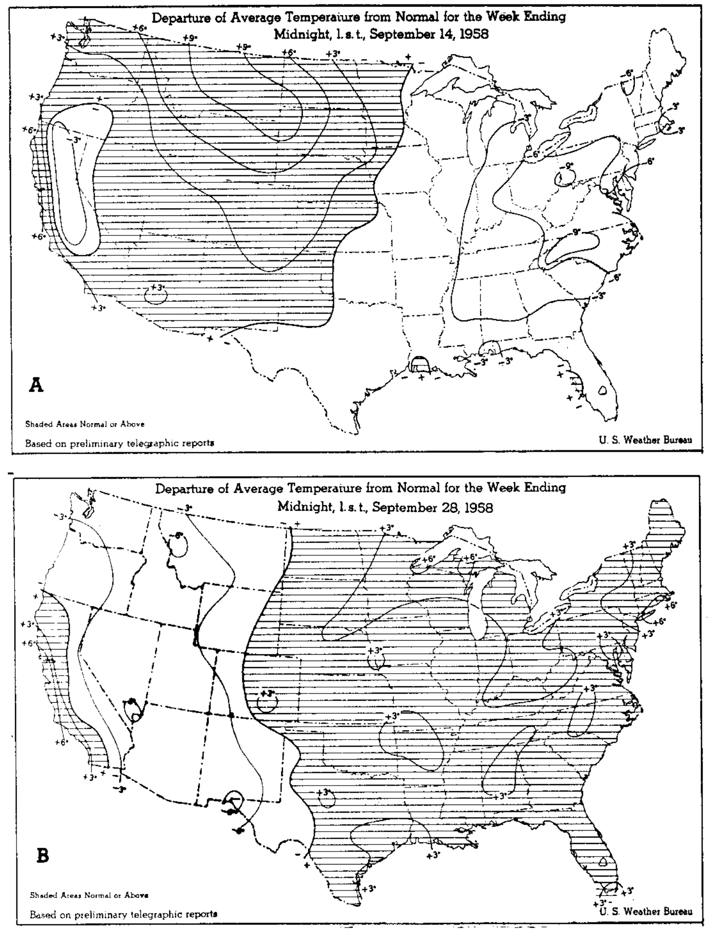

FIGURE 4.—Departure of average surface temperatures from normal (° F.) for weeks ending September 14 (A) and September 28 (B). Note the temperature reversal. (From *Weekly Weather and Crop Bulletin, National Summary*, vol. XLV, Nos. 37 and 39, September 15 and 29, 1958.)

The rainfall amounts were small, but were greater than the monthly normals which are less than an inch in this area. The remainder of the country was generally quite dry under anticyclonic conditions. The dryness in the Middle Atlantic States was interrupted by the passage of hurricane Helene which caused considerable precipitation along the Carolina coast. Cape Hatteras reported 4.46 inches (72 percent of its monthly total) and Wilmington, N.C., reported 8.24 inches (82 percent of its monthly total) during that 24-hour period.

TEMPERATURE

With the exception of the Pacific coast, temperatures for the month did not depart greatly from normal in most areas of the United States (Chart I-B) as height anomalies were also small. To some extent the small temperature departures were due to different regimes that occurred during the month under the rapidly changing 700-mb. height fields characteristic of high index.

Figure 4, A and B, shows an example of the temperature reversal that occurred over the United States during the month. In the earlier period (fig. 4A), the temperatures were warm in the West and cold in the East as a large-amplitude planetary wave was situated over the United States with a ridge centered over the Plains States and a trough along the east coast (fig. 5C). With northerly flow, temperatures averaged as much as 12° below normal in Asheville, N. C., and as much as 9° below normal in Pittsburgh, Pa., as a large part of the East had negative temperature anomalies greater than 6°. In the West, the warmest temperatures were in Montana, Wyoming, and the Dakotas where anomalies were generally in excess of +6°, with Miles City and Great Falls, Mont., reporting the greatest departures (+11° and +10°, respectively). Temperatures along the Pacific coast continued warm, as they had been for the past months, with the greatest departures at San Francisco (+7°) and Eureka (+6°). A stagnant trough off the coast fed cool moist Pacific air

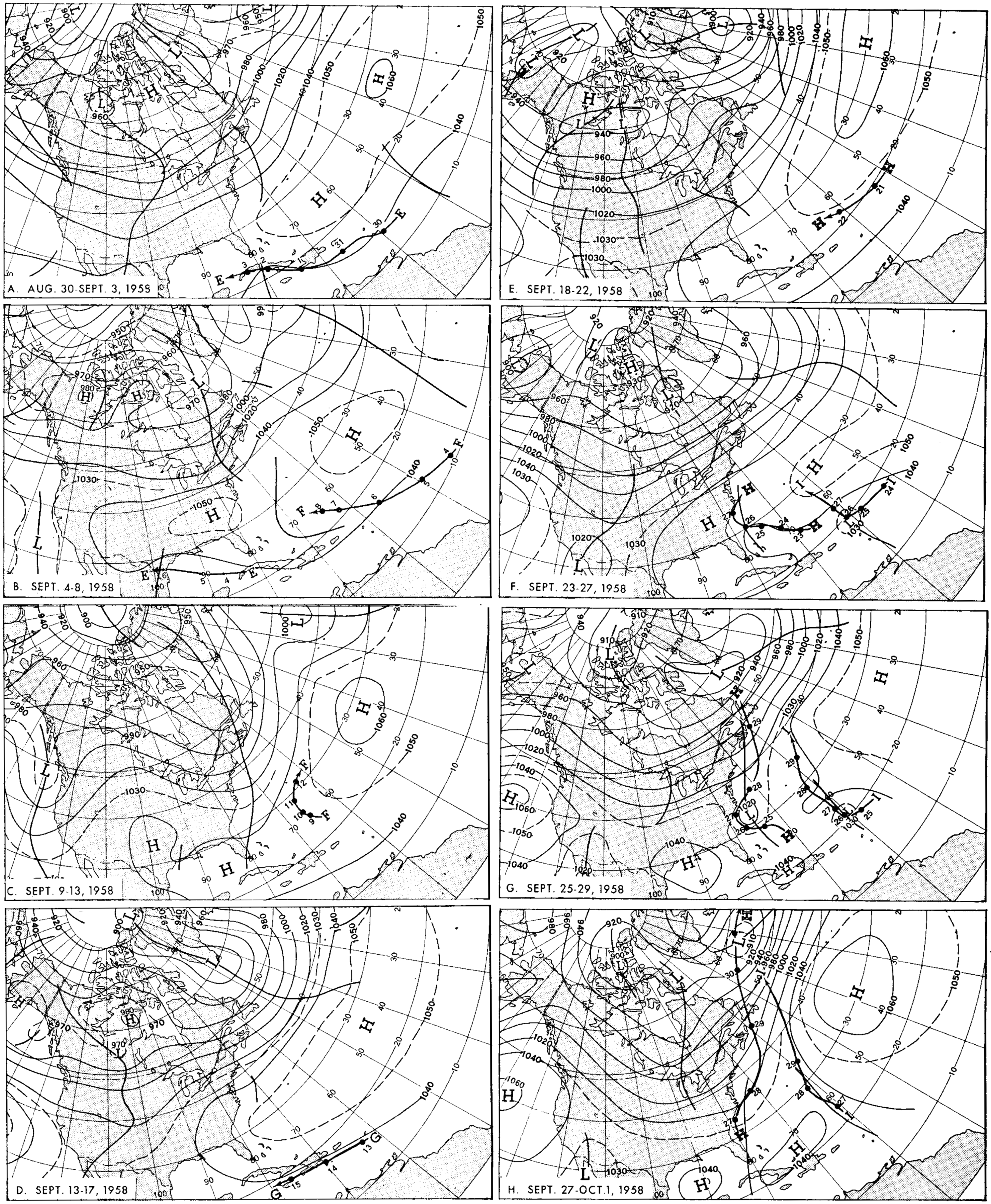

FIGURE 5.—A series of partially overlapping 5-day mean 700-mb. maps (contours in tens of feet) for selected periods in September 1958. The tracks of Ella, Fifi, Gerda, Helene, and Ilsa (labeled E, F, G, H, I) at sea level are shown by broad arrows. Solid circles indicate 1200 GMT positions on the dates given.

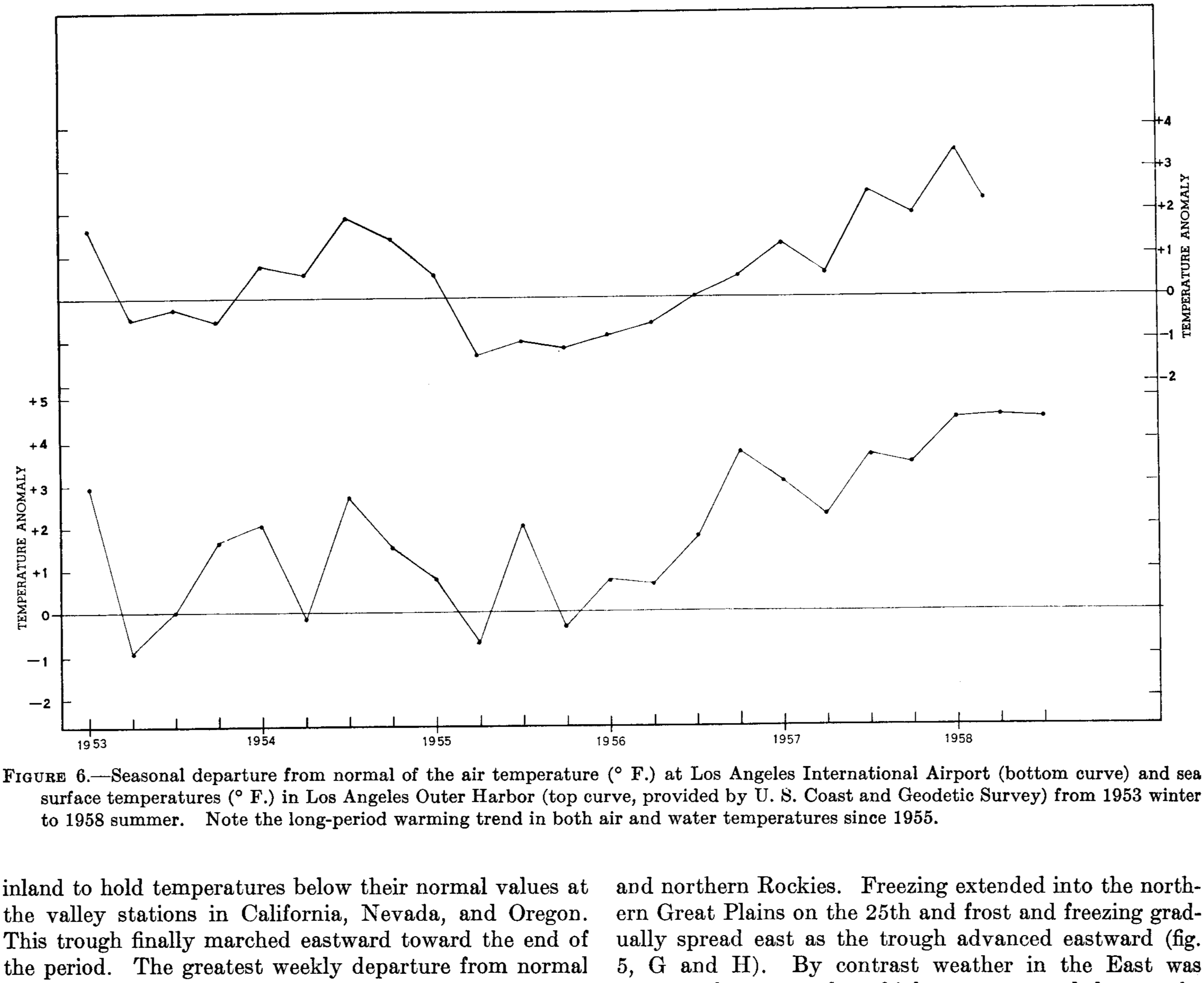

FIGURE 6.—Seasonal departure from normal of the air temperature (° F.) at Los Angeles International Airport (bottom curve) and sea surface temperatures (° F.) in Los Angeles Outer Harbor (top curve, provided by U. S. Coast and Geodetic Survey) from 1953 winter to 1958 summer. Note the long-period warming trend in both air and water temperatures since 1955.

inland to hold temperatures below their normal values at the valley stations in California, Nevada, and Oregon. This trough finally marched eastward toward the end of the period. The greatest weekly departure from normal was reported at Blue Canyon, Calif. (−7° F.).

In the latter half of the month the circulation was changed (fig. 5F). With a ridge flanking either coast and a trough extending from the Dakotas to Baja California, the temperature pattern readjusted itself. Cold weather was the rule in the West. Low temperatures of 31° F. at Salt Lake City, Utah, on September 25, and 12° F. at Winnemucca, Nev., on the 24th established records for so early in the year. A record low for the date was also set in Reno, Nev., on the 24th when the temperature was 21° F. This cold weather was attended by snow in the middle

TABLE 2.—*Unusual warmth on California coast during September 1958*

Station	Remarks
Los Angeles (city office)	3d warmest September in 81 years of record.
Los Angeles (airport)	Decidedly warmest September of record (begun in 1931).
Oakland	September average temperature 2.0° higher than record (begun in 1929).
San Diego	Second warmest September in 87 years of record.
San Francisco	Warmest of any month in 88 years of record.
Santa Maria	Warmest September in 20 years.

and northern Rockies. Freezing extended into the northern Great Plains on the 25th and frost and freezing gradually spread east as the trough advanced eastward (fig. 5, G and H). By contrast weather in the East was warmer than normal as high pressure settled over the Southeast, and broad southerly flow prevailed across the eastern two-thirds of the United States. Afternoon temperatures were in the 80's and 90's as weekly departures in excess of +5° were observed in such diverse areas as the Northern Great Lakes, Ohio, New England, and the southern States of Kentucky and Louisiana. Meanwhile, despite the change in circulation, the record warmth along the Pacific coast persisted.

Temperatures along the California coast have been considerably warmer than normal for 6 consecutive months. Records and near records were experienced at many stations this September (table 2) and this warm regime has carried over into October.

The unusual warmth at coastal cities in California may have begun several years ago. From Los Angeles records it is apparent that some fluctuation in the direction of warmer than normal conditions has been occurring for the last couple of years, with the greatest change along the coast. The airport station, about 3 miles inland, has been warmer than normal uninterruptedly since

May 1956, with temperature in 19 of these months in the "much above" category.[2] Such preponderance of events of a similar nature is extremely unlikely, if, in fact, the temperatures are distributed randomly in time. Compared to the airport, the city office, about 12 miles inland, has shown a similar warmth, but perhaps not as marked. Here below normal temperatures were observed 4 times in 29 months and above normal 5 times, with much above observed 14 times.

This apparent increase in temperature cannot be ascribed to a change in the normals used in computing the temperature departures. These normals were last changed in January 1953 and these persistent abnormalities were not discernible until May 1956. Furthermore the location of the thermometer has not been changed at either the airport or the city office since 1949.

It has been suggested [11, 12, 15, 16] that this phenomenon may be in part linked to above normal sea surface temperatures in the coastal waters. A report by the California Cooperative Oceanic Fisheries Investigations [3] stated that water temperatures in Monterey Bay and the ocean beyond have shown a general warming trend since 1955; shore conditions show the same trend. These oceanic temperatures are frequently related to air temperatures at neighboring land areas. For example, Gorton [6] found a close correlation between simultaneous air temperatures at San Diego and sea surface temperatures at La Jolla.

Figure 6, a time graph of the seasonal departure from normal of both the air temperature at Los Angeles Airport and the water temperature in Los Angeles Outer Harbor during the years 1953 to 1958, indicates the general parallelism of water and air temperatures for such averages. Note especially the warming trend in both sea and air temperature since about 1955 (about the time it was noted in Monterey Bay).

If the sea surface warming were general, its effects should be discernible at other coastal cities. San Diego's temperature record was examined and the same trend was present. The temperature fluctuated more or less around the normal up to May 1956. Since then the monthly mean temperature has been below normal only once, whereas it was much above normal for 15 months. A similar warming has been noted at San Francisco, where since May 1956 air temperatures have been below normal 3 times and much above 12 times. Oceanic warming has been noted at both San Diego and San Francisco coincidentally with the rise in air temperature.

There is additional evidence that air temperatures along the California coast have been warmer than suggested by the atmospheric circulation. An objective scheme for forecasting temperature at many cities including San Diego has been recently devised by Klein et al. [10]. This method is dependent solely on atmospheric circulation parameters objectively selected from 1947–57 data as the "best" ones to describe the temperature anomaly at each city. It was tested on independent data for the 1957–58 winter. At San Diego, 64 forecasts were made of the temperature anomaly, and all 64 forecasts were too cold. One may therefore infer that the bias of the forecasts was due to something additional to the atmospheric circulation, and this discrepancy has been attributed to warmer than normal sea surface temperatures [10].

[2] In a statistical breakdown of temperatures at a given station, used in the Extended Forecast Section, one-fourth of the cases are in each of three categories (above, normal, and below) and one-eighth of the cases in each of the extreme groups (much above, much below).

4. TROPICAL STORMS RELATED TO THE MONTHLY MEAN CIRCULATION

ATLANTIC STORMS

Four tropical storms formed in the Atlantic this September; three developed hurricane strength. Although this was in excess of the mean values of 3 storms and 2 hurricanes during the past 70 Septembers, it was just about normal for recent years. Since 1953 this frequency of storms has been observed 6 years in succession. In fact the short-period means for the past 10 years are the same as observed values this September. A monthly storm intensity index was designed by Haggard and Cry [7] to show the relative importance of the tropical storminess for each month. The value computed for this month was exceeded in one-fourth of the Septembers since 1900, and was about normal for recent years.

Tropical storms showed a strong tendency to form in the vicinity of the Antilles this September (fig. 1A). The circulation this month resembled the composite picture found favorable for genesis in this area [1] with a ". . . large circular area of positive anomaly in the central Atlantic with a negative anomaly area cresting across the north. . . . Associated with this anomaly pattern is strong easterly flow at low latitudes. To the northeast of the Antilles the mean wind is 8 m. p. s. from the east; to the northwest 5 m. p. s. from the east. Such a convergent picture may be associated with the deepening of easterly waves in that vicinity." Compare the description of the composite picture with the circulation observed this month (figs. 2, 3A, 3B). The storms (fig. 1B) formed in the vicinity of the mean easterly jet (fig. 3A) with convergence indicated to the north of the Antilles. The tropical storms of the Pacific also apparently developed in the vicinity of the easterly jet. This supports Dunn's thesis [4] that tropical storms *do not* form in the doldrums and is in agreement with Klein's observation [9] of cyclogenesis occurring in the vicinity of jets both in middle latitudes and in subtropical areas. Cyclonic vorticity was also evident in the area of formation, as may be inferred from negative anomaly in figure 2.

Three of this month's storms moved northward in a broad trough and southerly anomalous flow off the east coast of the United States. The relation of these tropical storm tracks to shorter-period mean circulation will be discussed in the next section.

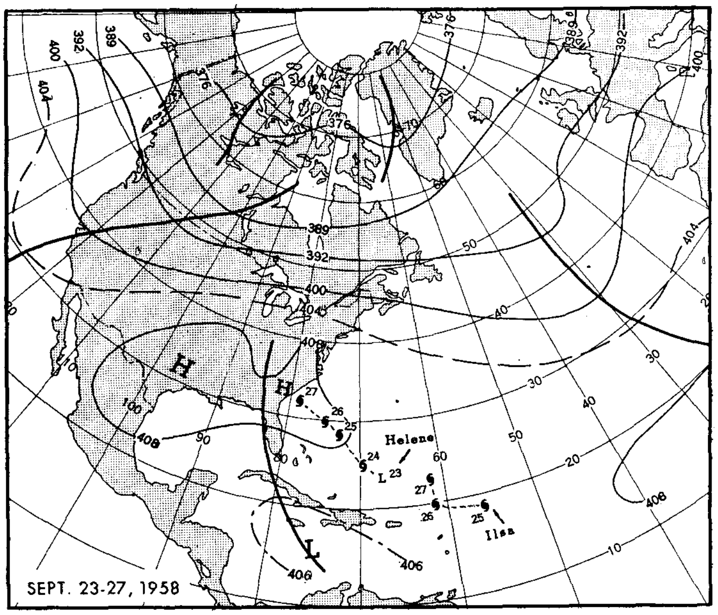

FIGURE 7.—Mean 200-mb. height contours for September 23-27, with tracks of hurricanes Helene and Ilsa superimposed. Helene developed to hurricane strength under northerly flow aloft.

EASTERN PACIFIC

Of interest were the three tropical storms which formed in the eastern Pacific near Mexico (fig. 1B) in an area where heights were considerably below normal (fig. 2). Note the negative anomaly center of 110 ft., the greatest of record for September in this area. All three of the storms were steered quite well by both the mean flow and the anomaly flow, which were in phase over the eastern Pacific. The storm with the long westward track was the only one to attain hurricane strength.

WESTERN PACIFIC

When the month began Typhoon Grace had already formed and was moving through the East China Sea just to the north of Formosa (fig. 1A). It thence recurved, passing into the Yellow Sea to the south of Korea. During September, only three typhoons formed, which was less than the normal for the month [5]. The northward steering of Helen and Ida were well indicated by the southerly flow evident on the monthly mean chart (fig. 2). They both skirted the east shore of Honshu, a common track for typhoons in September [8]. June formed in a rare longitude for typhoons and took an even rarer path, but one which was in accordance with the performance of many storms, moving northward in a mean trough.

5. TROPICAL STORMS RELATED TO THE 5-DAY MEAN CIRCULATIONS

The relationships between tropical storm motion and the circulation [2] are somewhat coarser the longer the time-period involved. When we study shorter-period mean circulations, the dominant features governing the path of the storms are often more evident; but in times of rapid change this is not always the case. Some of the characteristic behavior of hurricanes in relation to the concurrent large-scale circulation patterns can be seen in this section, where each 5-day mean 700-mb. map is discussed in chronological order with respect to the track(s) of the tropical storm(s) of that period.

Ella developed on August 30 in a strong easterly wave. Traveling west-northwestward imbedded in easterly flow (fig. 5A), Ella developed into a hurricane on August 31 west of Puerto Rico. After crossing the southern peninsula of Haiti with winds of 110 m. p. h. on September 1 and causing extensive damage there, the hurricane continued in a track along the southern coast of Cuba. The circulation became disorganized in crossing the Sierra Maestra Range, and the storm never did regain its potency as it once more encountered water in the Gulf of Mexico on the 3d. With no westerly trough to its north, Ella continued its west-northwestward path across the Gulf of Mexico (fig. 5B) entering the southern Texas coast on the 6th. This is an unusual port-of-entry for September storms originating in the Antilles. An additional note concerning Ella: In its first 2 days, the storm moved at a pace more rapid than considered normal, but its speed was justified by the strength of the flow (fig. 5A).

At the time Ella was moving across the Gulf of Mexico, another easterly wave was developing a circulation to the east of the Antilles (fig. 5, A and B). The western lobe of the Bermuda High (fig. 5A) had progressed eastward (fig. 5B), and meanwhile another high center developed in the southeastern United States. Fifi moved on a northwest track until the 9th, heading toward the weak trough between the two Highs, attended by winds reaching 85 m. p. h. on the 6th. Winds weakened thereafter as the circulation aloft was not favorable for continued deepening. The anticyclone in the Atlantic progressed farther eastward and intensified as the wave pattern from the Pacific to the Atlantic amplified (fig. 5C). Fifi recurved as the flow in its environment became more southerly. On the 11th its movement accelerated to the northeast as it moved into the westerlies near Bermuda.

By mid-September, the circulation from the Pacific to the Atlantic had regained its high index characteristics (fig. 5D). On the 13th, Gerda, a weak cyclonic circulation, was estimated to be located about 130 miles west of Martinique. Never developing into much more than a fast-moving, moderately strong, easterly wave, Gerda's track was associated with strong easterly flow at 700 mb. (fig. 5D).

Helene formed in an easterly wave and developed into a storm on the 23d. It took a normal west-northwestward track south of the subtropical High (fig. 5E) and shifted more northwestward as the flow in that area changed (fig. 5F). The storm reached hurricane strength on the afternoon of the 24th when it was under the northerly flow of the anticyclone on the 200-mb. mean chart for the period September 23–27 (fig. 7). This is the divergent condition aloft that Riehl considers important for the deepening of tropical storms [14]. Helene's northwestward track until the 26th may have been motivated by height rises at 500 mb. in the Northeast on the 23d and

24th associated with energy dispersion out of a deepening trough in the Central Pacific (cf. fig. 5, E and F).[3] The rapidly changing broad-scale circulation underwent another fluctuation as heights fell strongly on the 26th at 70° and 80° W. as a trough approached the east coast. Against this background hurricane Helene started its recurve (fig. 5G), which sharpened on the 27th as the trough pushed through the Northeast. Helene sped northward contributing cyclonic vorticity to the Low south of Greenland (fig. 5, G and H).

Ilsa formed shortly after Helene in the same general area and moved eastward initially, its path paralleling that of its predecessor. Ilsa reached hurricane strength on the 25th; its deepening cannot be related to the mean 200-mb. chart (fig. 7), but the daily charts showed it to be in a favorable location with respect to a high-level anticyclone. On the 26th Ilsa curved sharply to the north in response to the falling away of heights in the north (previously discussed in the case of Helene) and continued to deepen, its wind speeds reaching 140 m. p. h. Associated with falling heights was the acceleration of a trough in eastern Canada eastward into the Davis Straits to amalgamate with a negatively tilted trough in the eastern Atlantic (fig. 5, F and G). This allowed the subtropical anticyclone to progress eastward and heights built in the western Atlantic behind the trough (fig. 5, G and H). Increased meridional flow in the Atlantic shifted the course of Ilsa to the north and then to the northeast as it entered the fast westerlies to the north. Ilsa lost its identity as an individual circulation on the morning of the 30th as the circulation of Helene engulfed it.

[3] Height changes at 500 mb. not reproduced.

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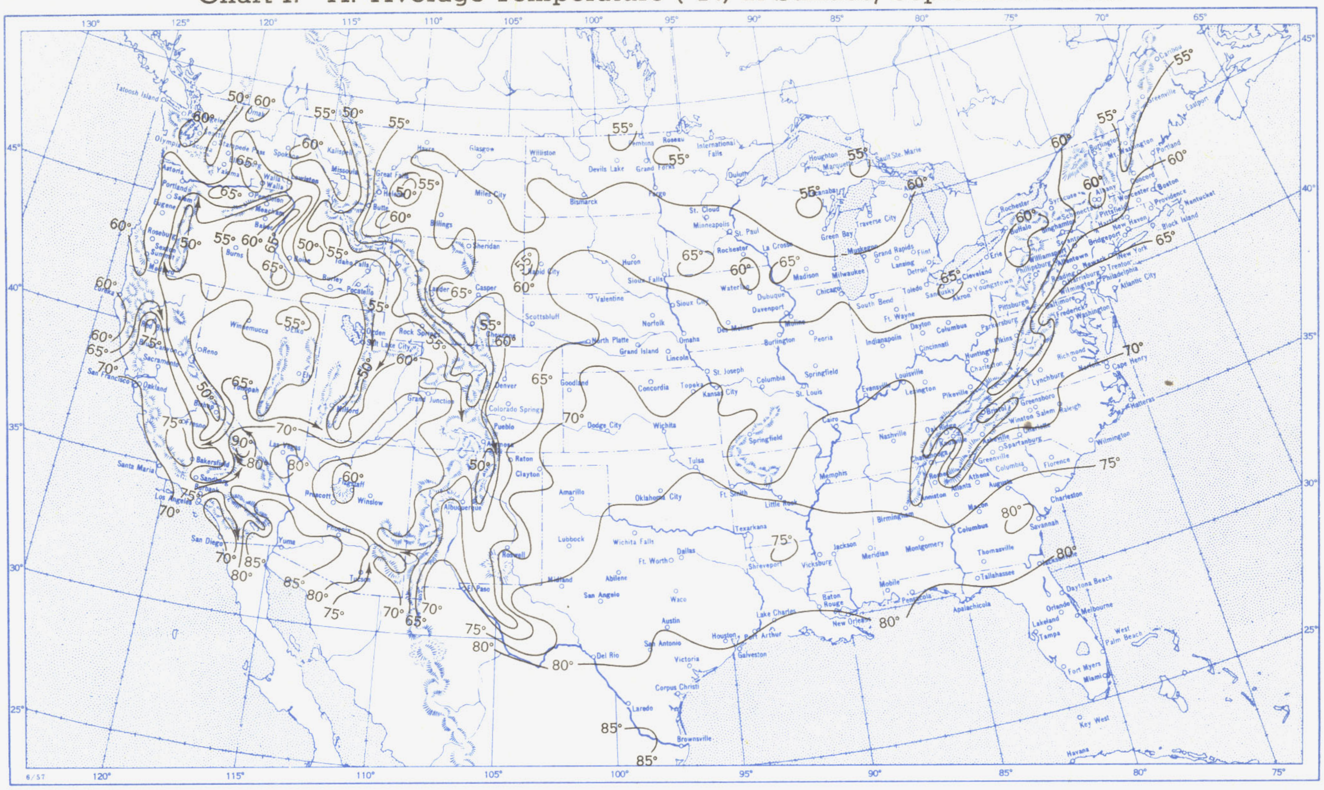
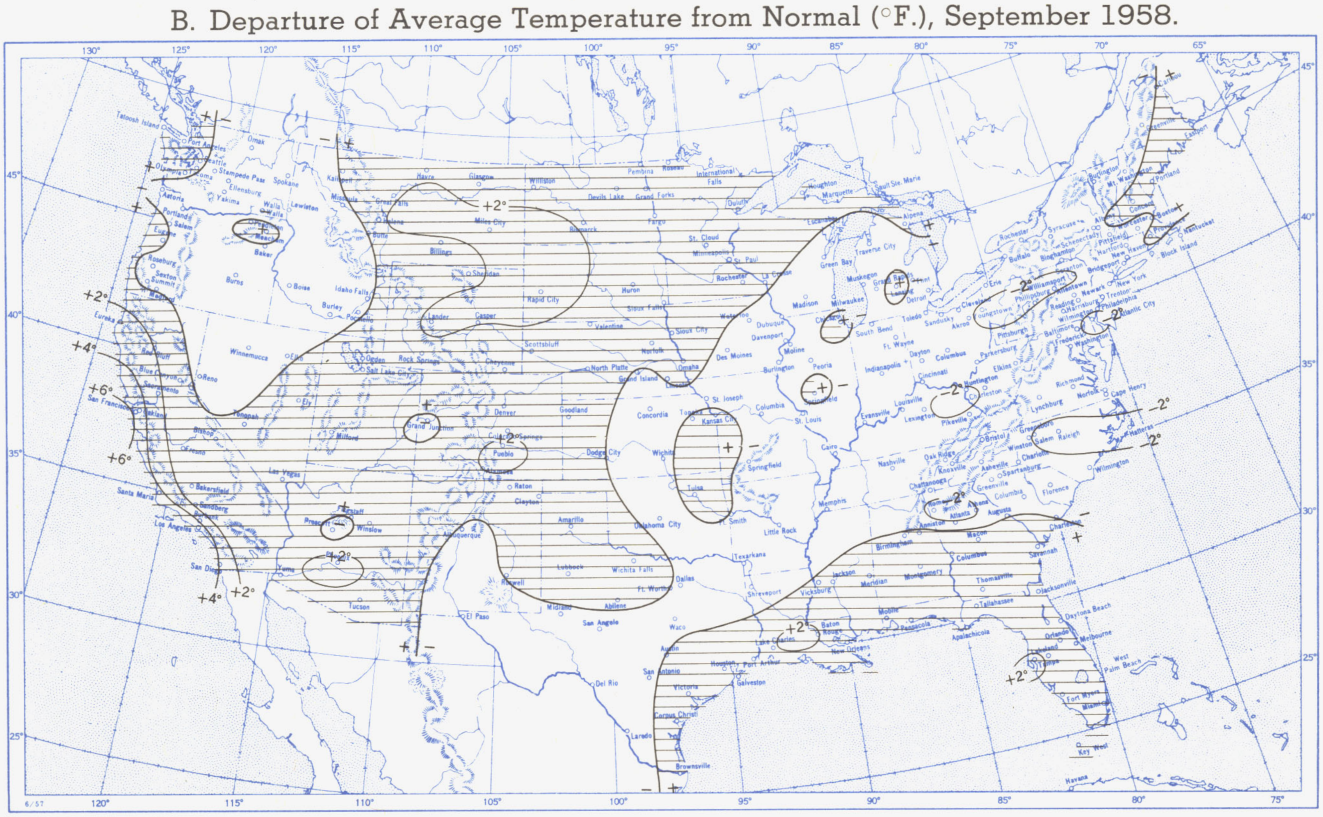
Chart I. A. Average Temperature (°F.) at Surface, September 1958.

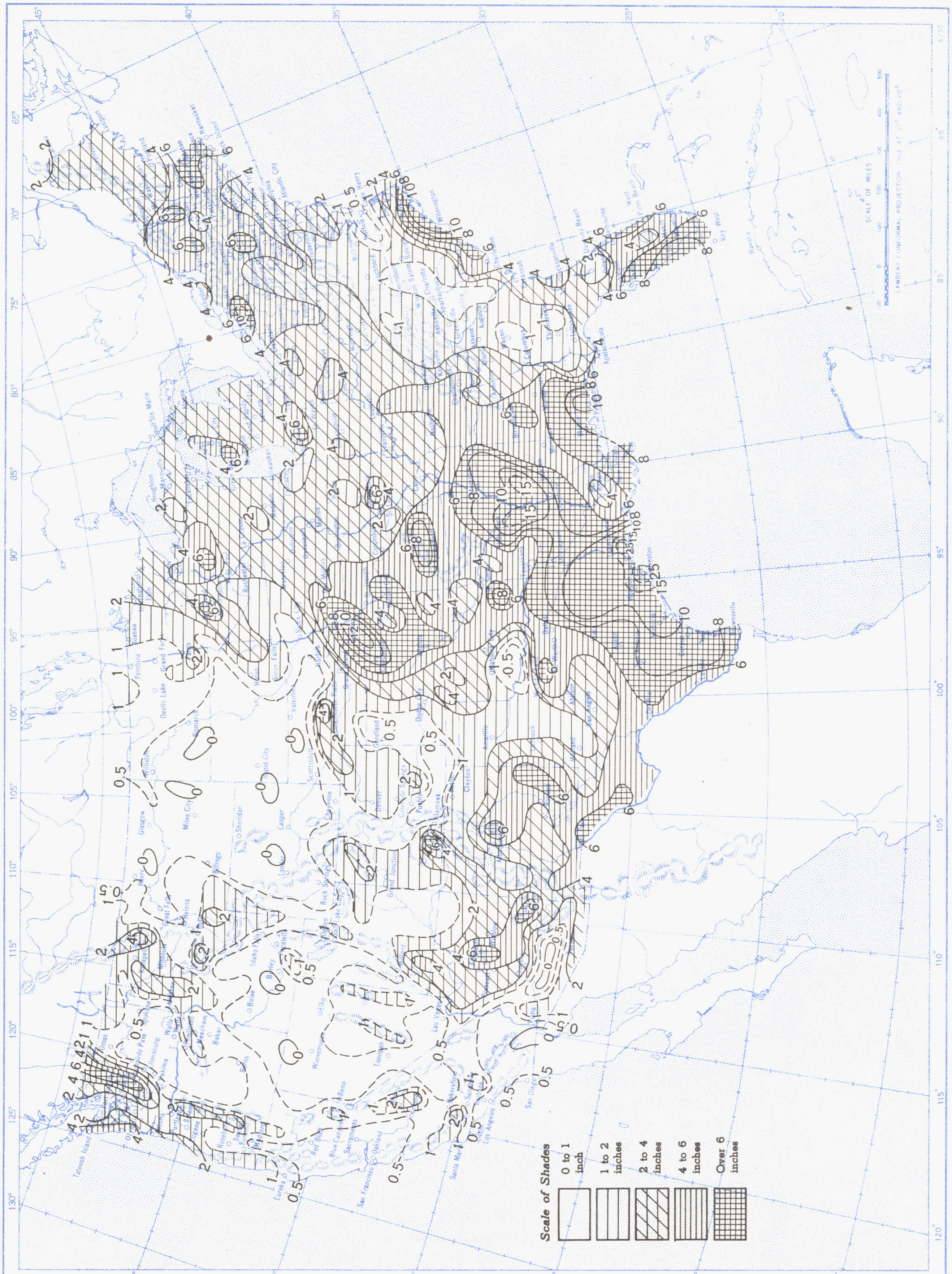


B. Departure of Average Temperature from Normal (°F.), September 1958.



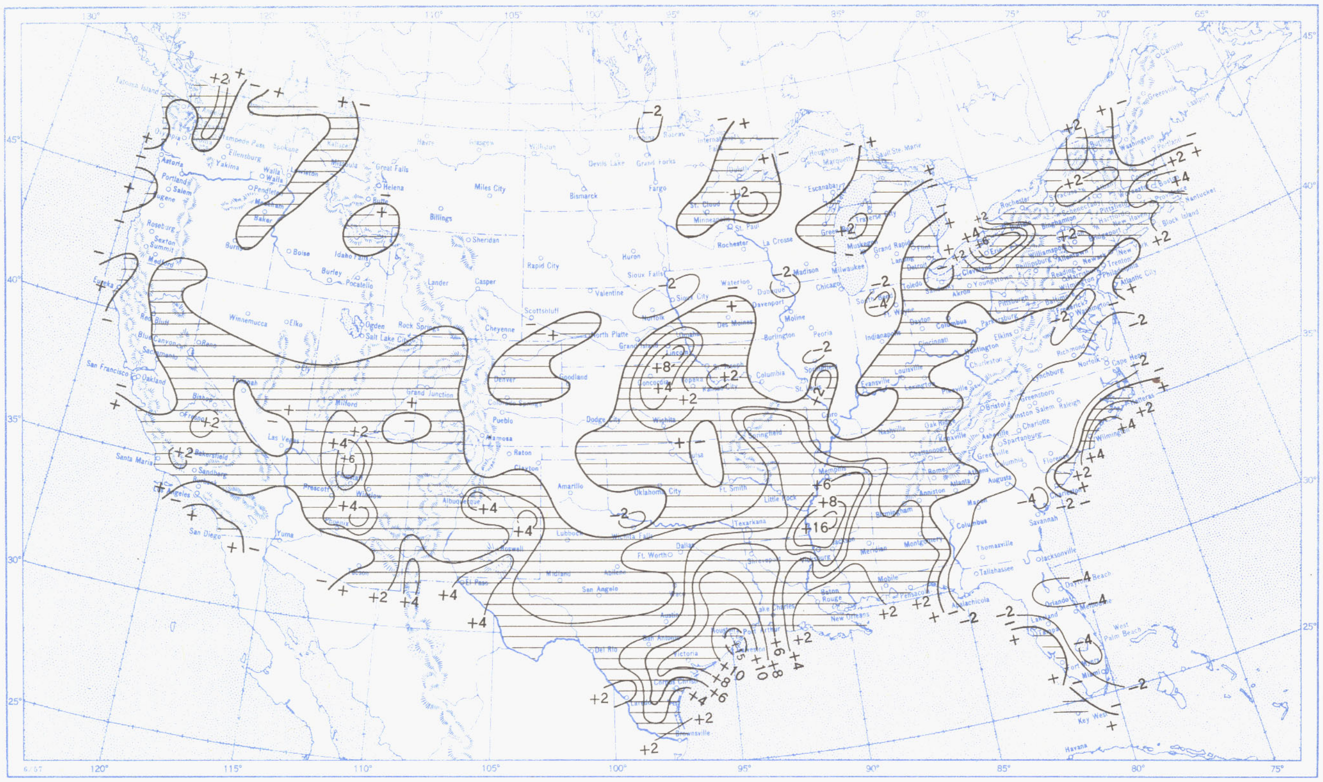
A. Based on reports from over 900 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Departures from normal are based on the 30-yr. normals (1921-50) for Weather Bureau stations and on means of 25 years or more (mostly 1931-55) for cooperative stations.

Chart II. Total Precipitation (Inches), September 1958.

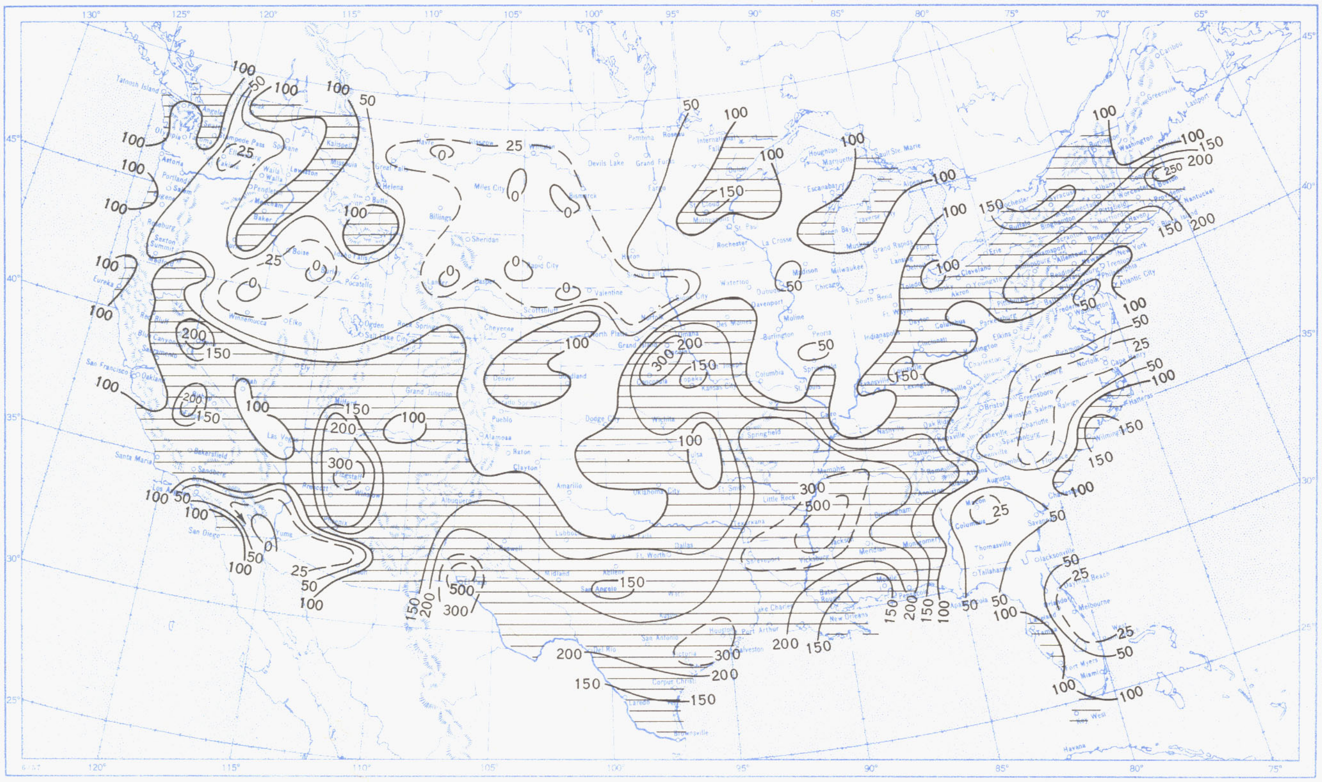


Based on daily precipitation records at about 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), September 1958.

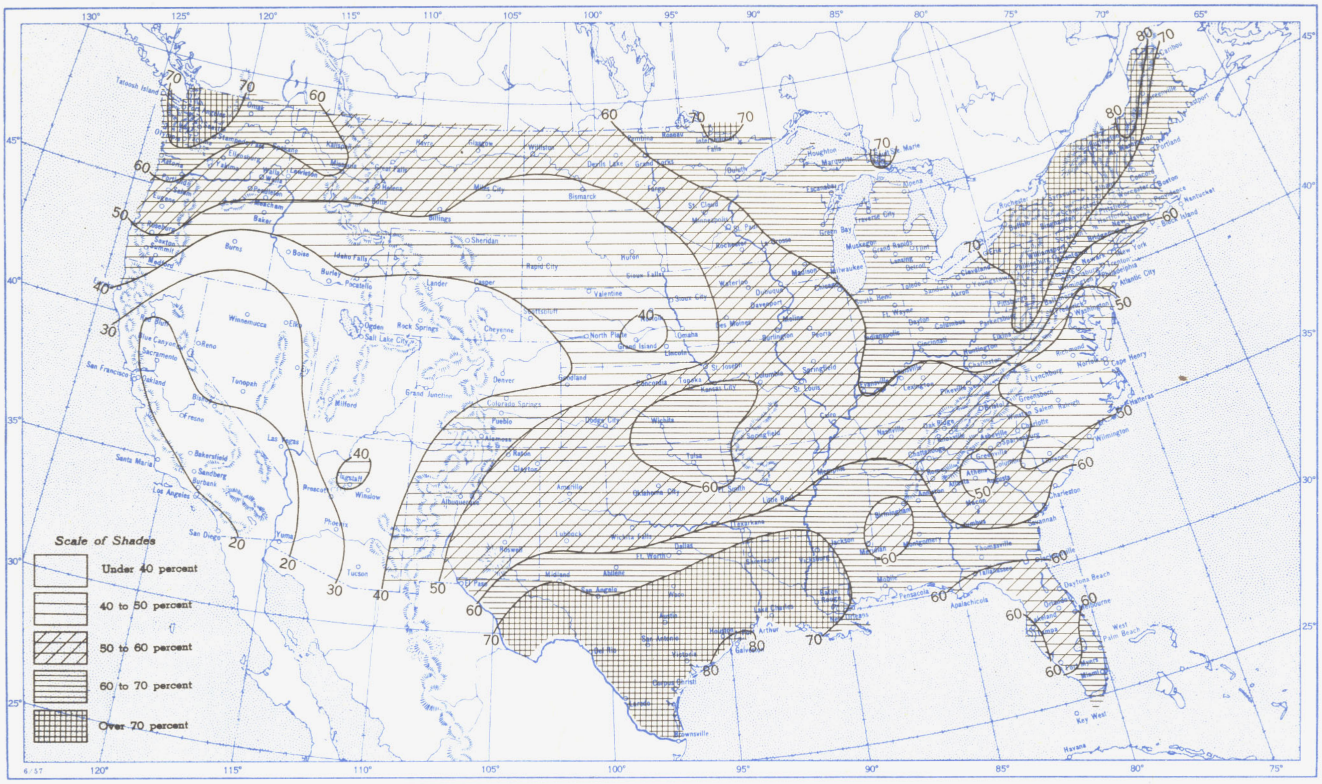


B. Percentage of Normal Precipitation, September 1958.

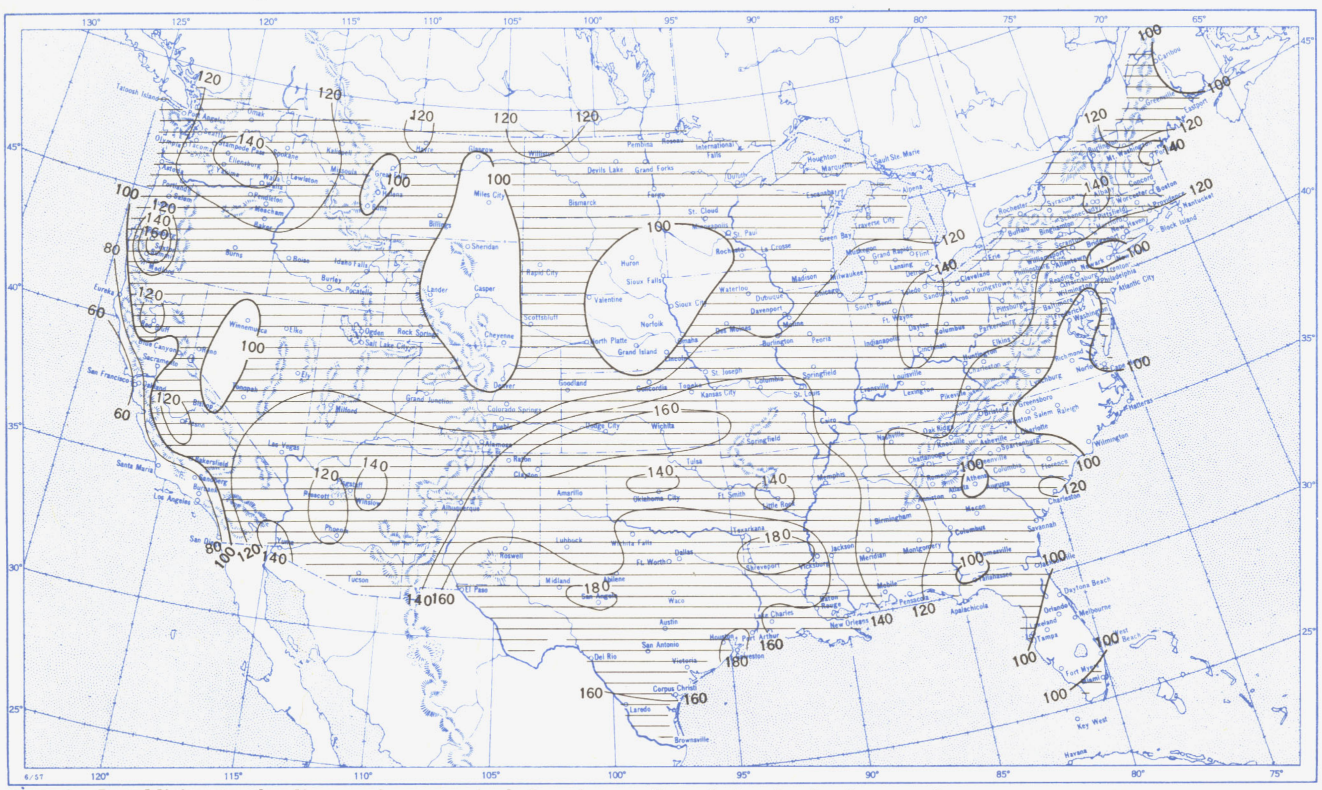


Normal monthly precipitation amounts are computed from the records for 1921-50 for Weather Bureau stations and from records of 25 years or more (mostly 1931-55) for cooperative stations.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, September 1958.

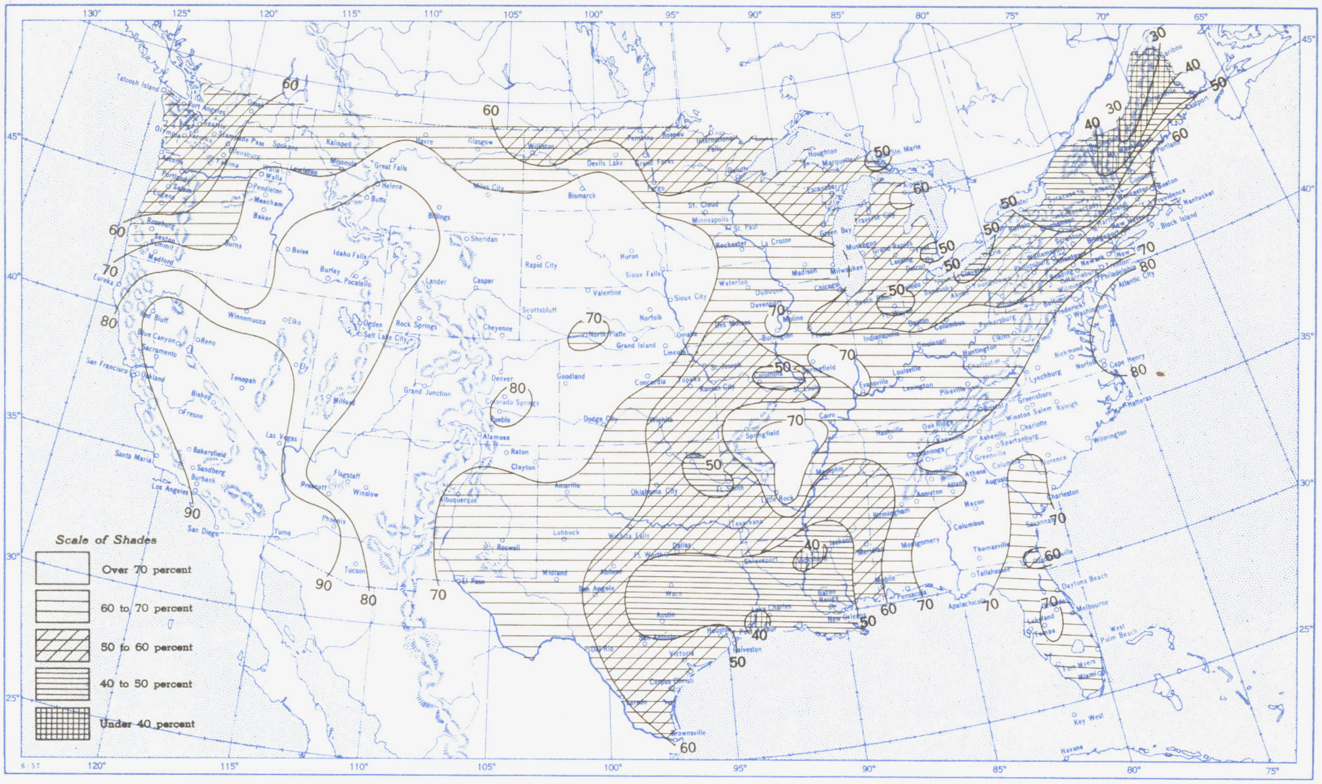


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, September 1958.

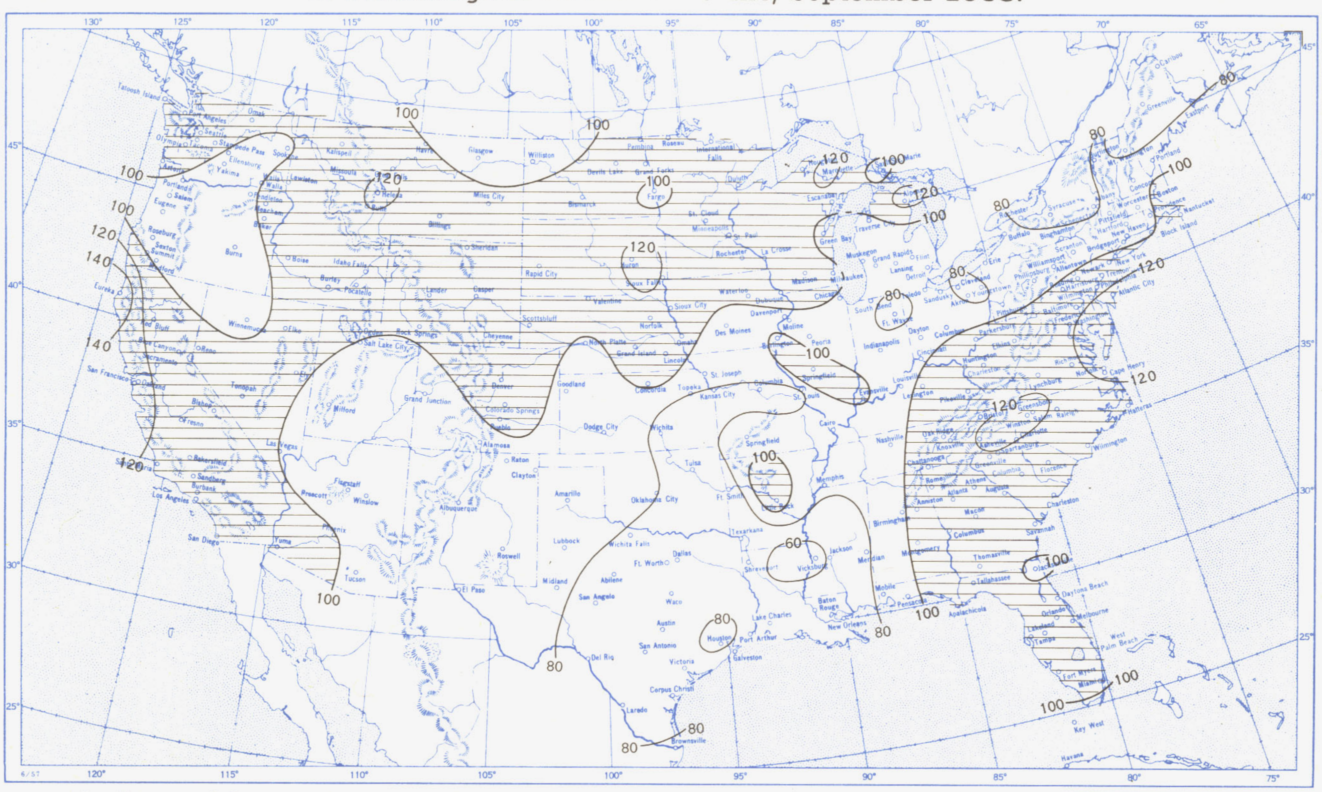


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, September 1958.



B. Percentage of Normal Sunshine, September 1958.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, September 1958. Inset: Percentage of Mean Daily Solar Radiation, September 1958. (Mean based on period 1951-55.)

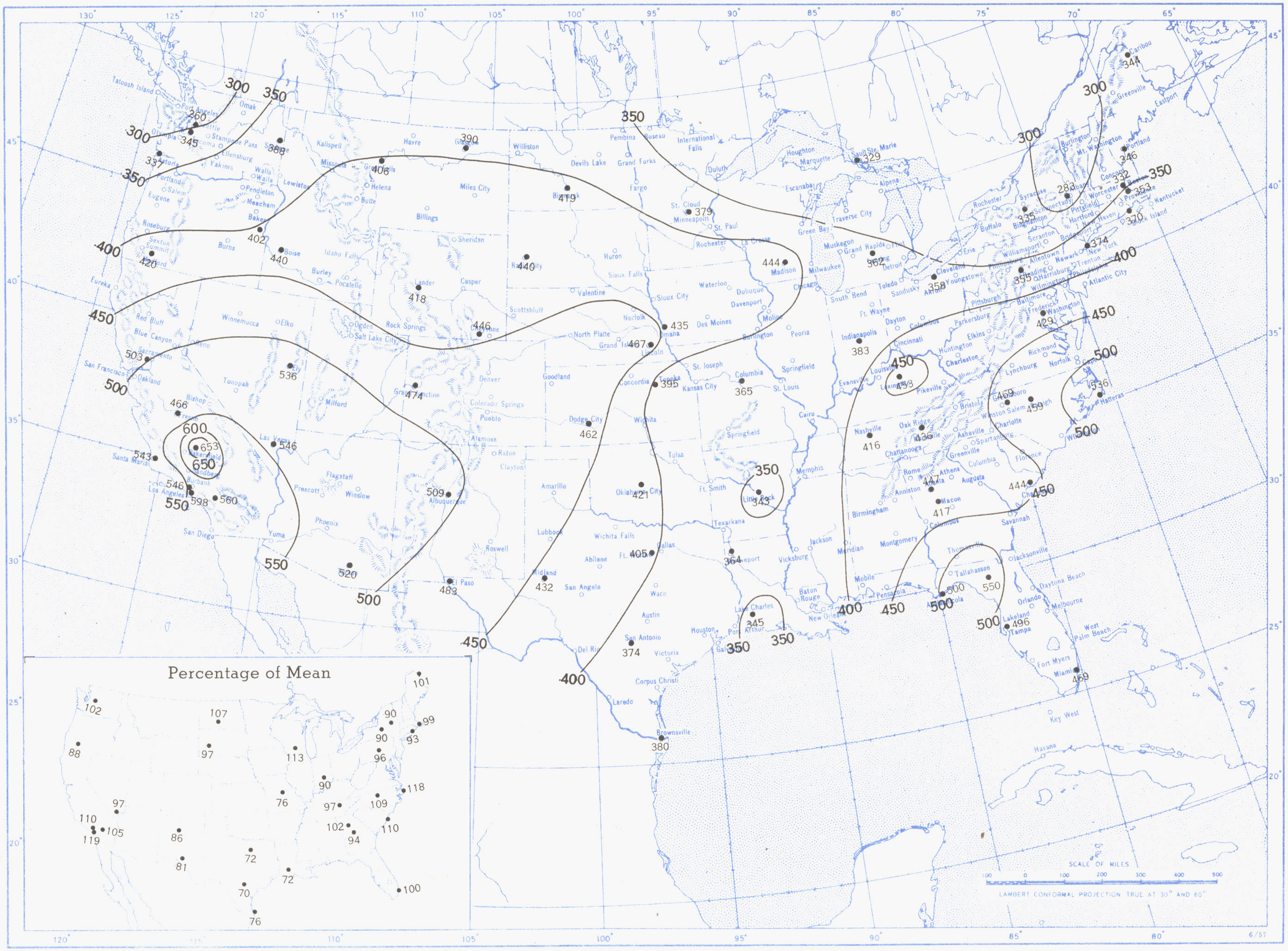
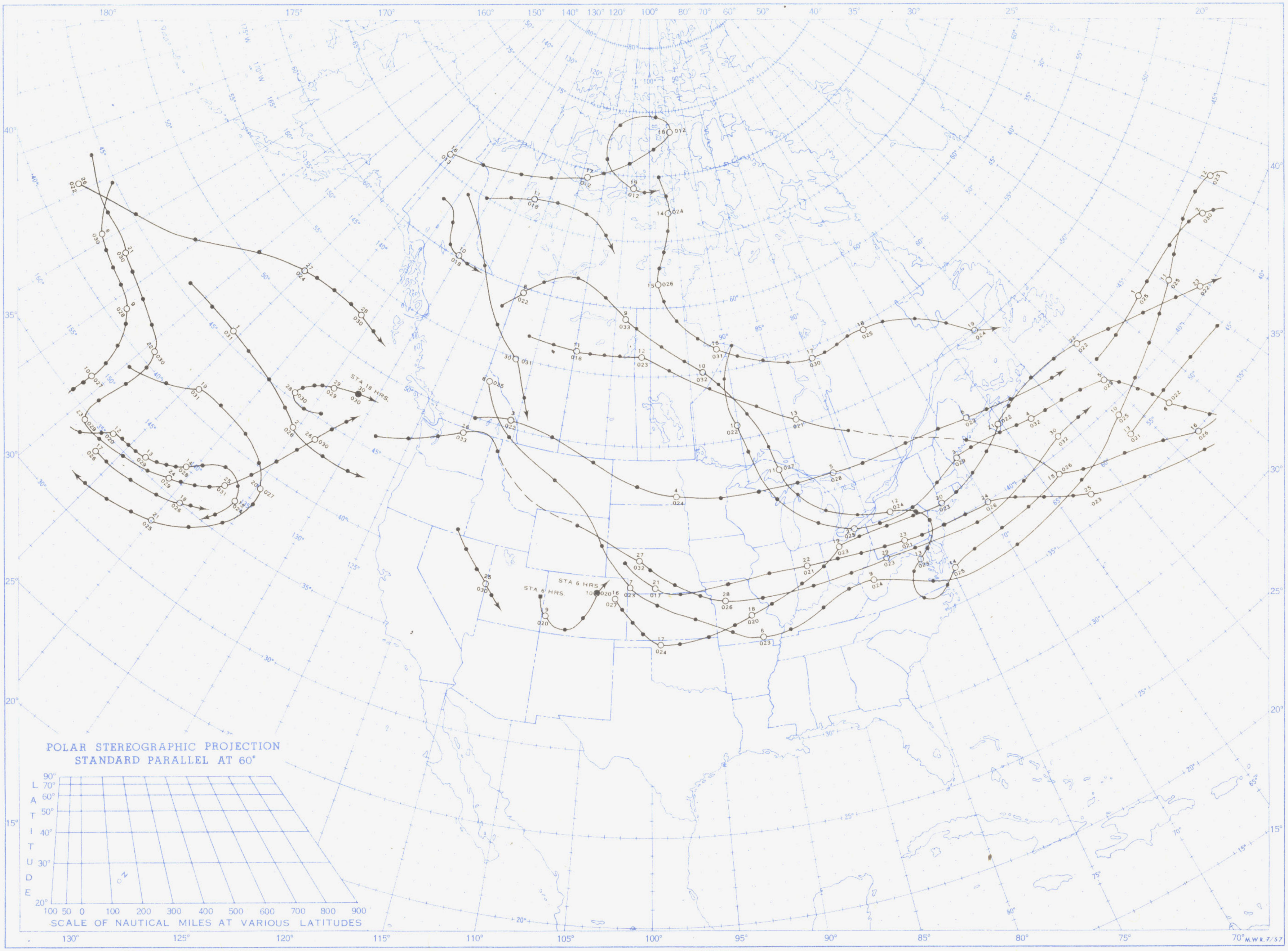


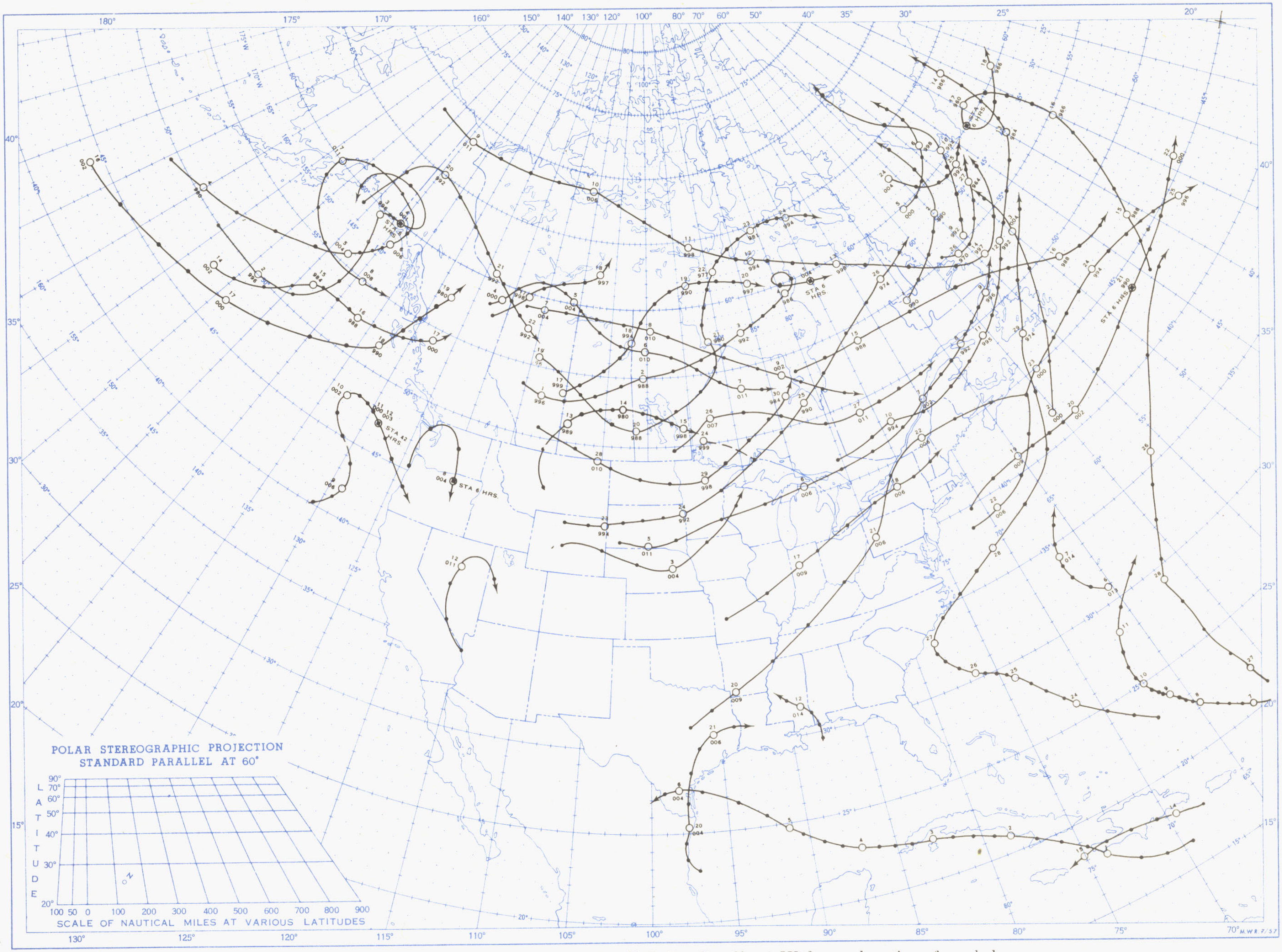
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm. $^{-2}$). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. The inset shows the percentage of the mean based on the period 1951-55.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, September 1958.



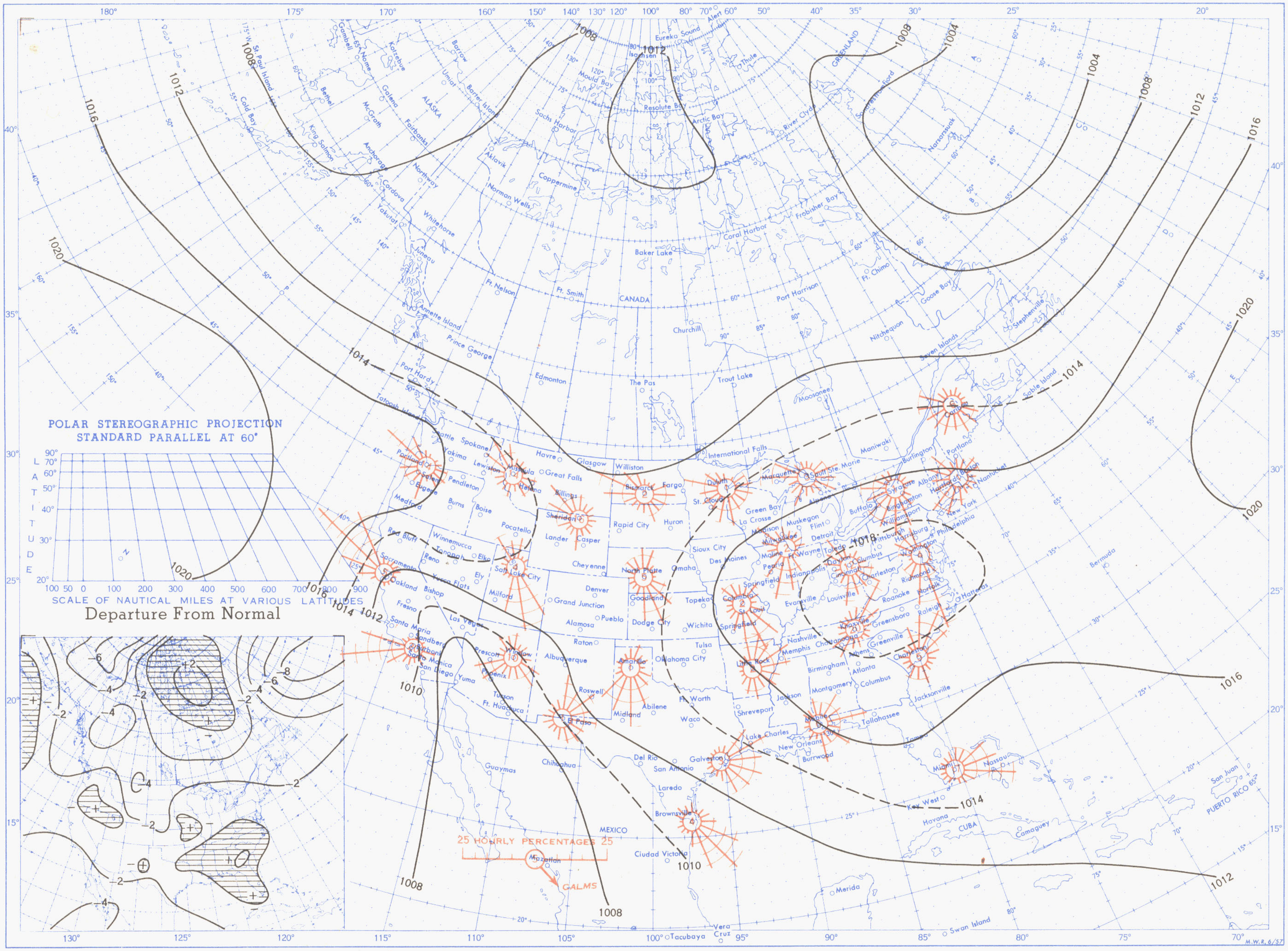
Circle indicates position of center at 7:00 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, September 1958.



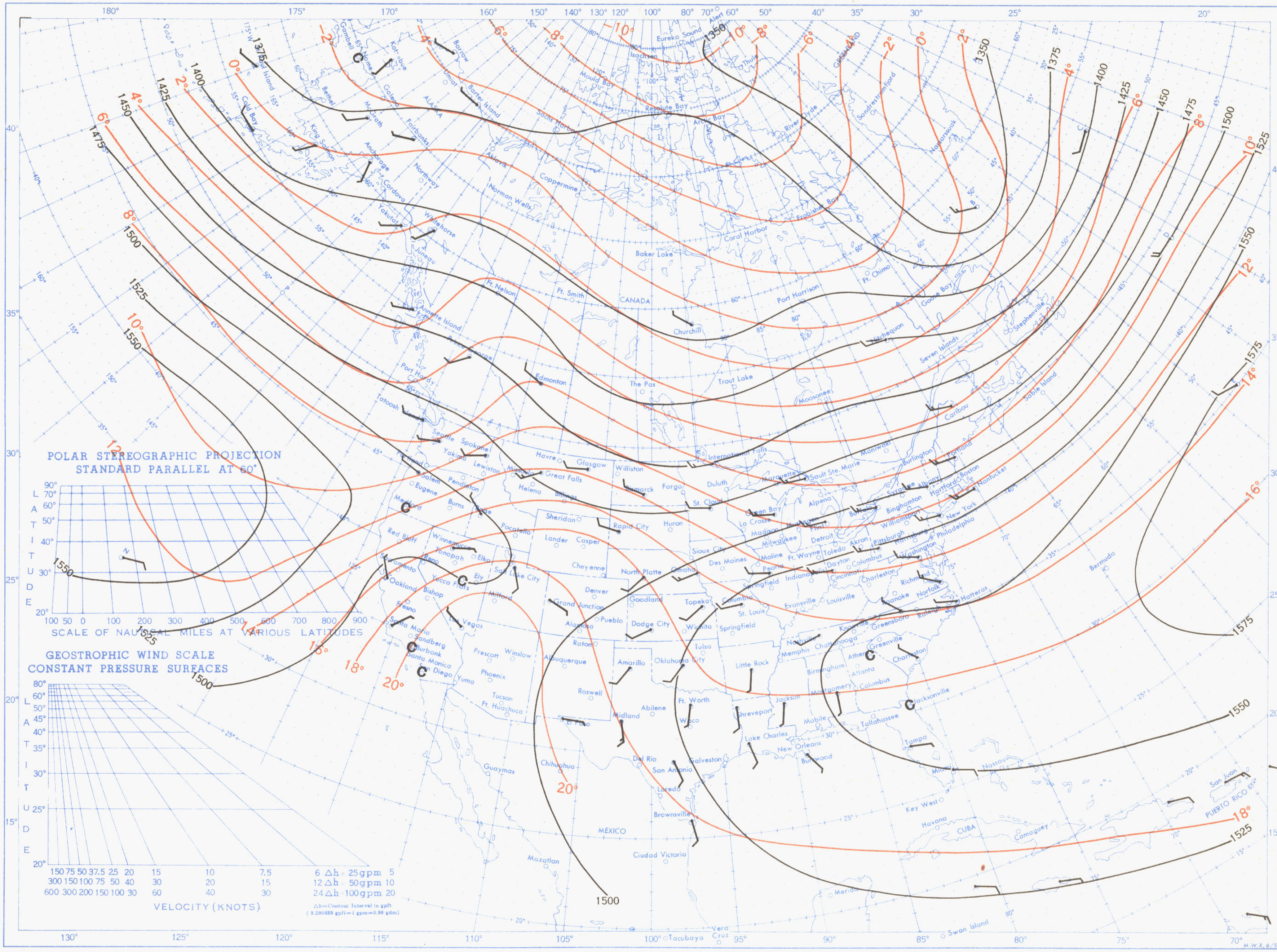
Circle indicates position of center at 7:00 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, September 1958. Inset: Departure of Average Pressure (mb.) from Normal, September 1958.



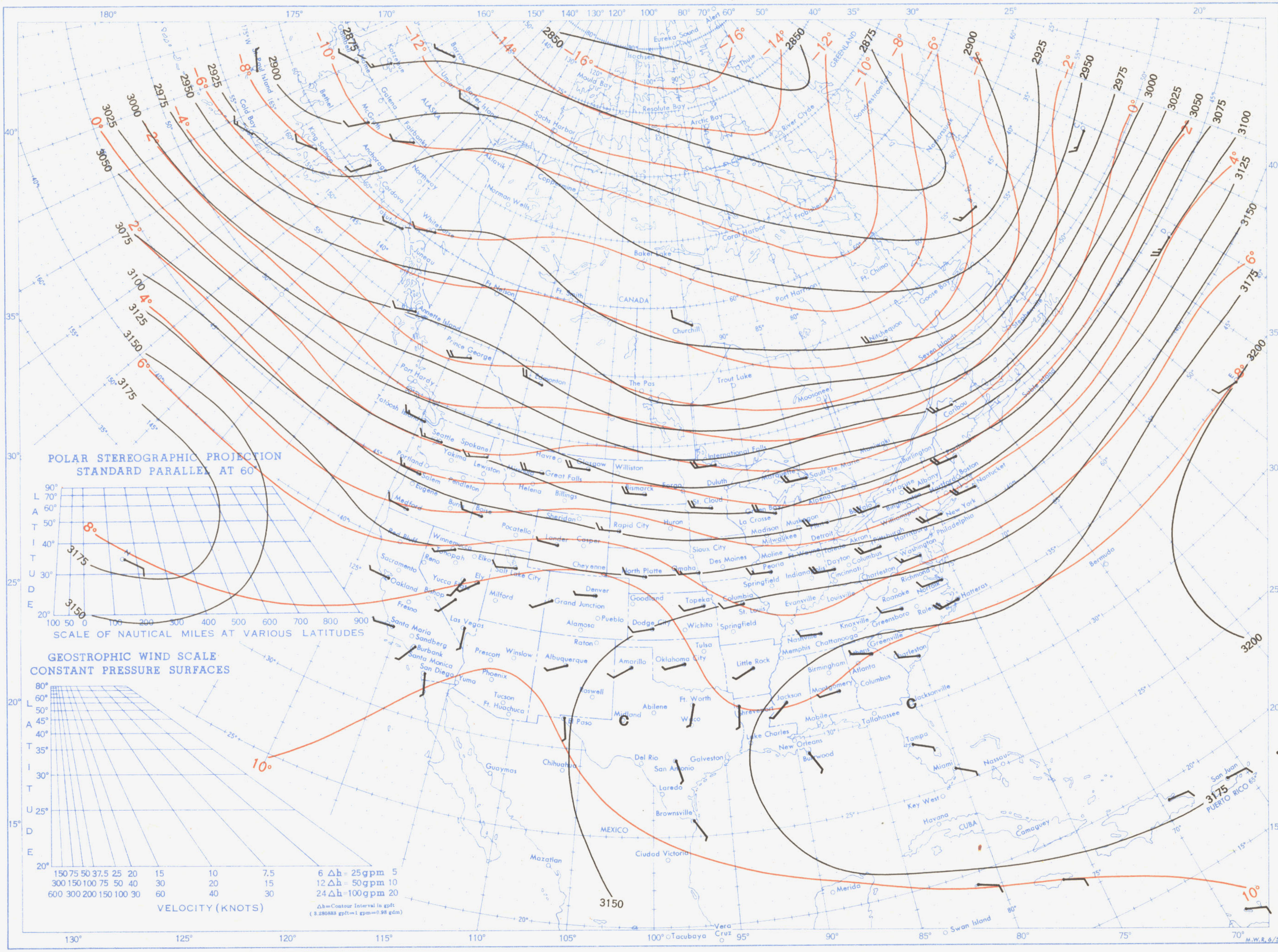
Average sea level pressures are obtained from the averages of the 7:00 a.m. and 7:00 p.m. E.S.T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. 850-mb. Surface, 1200 GMT, September 1958. Average Height and Temperature, and Resultant Winds.



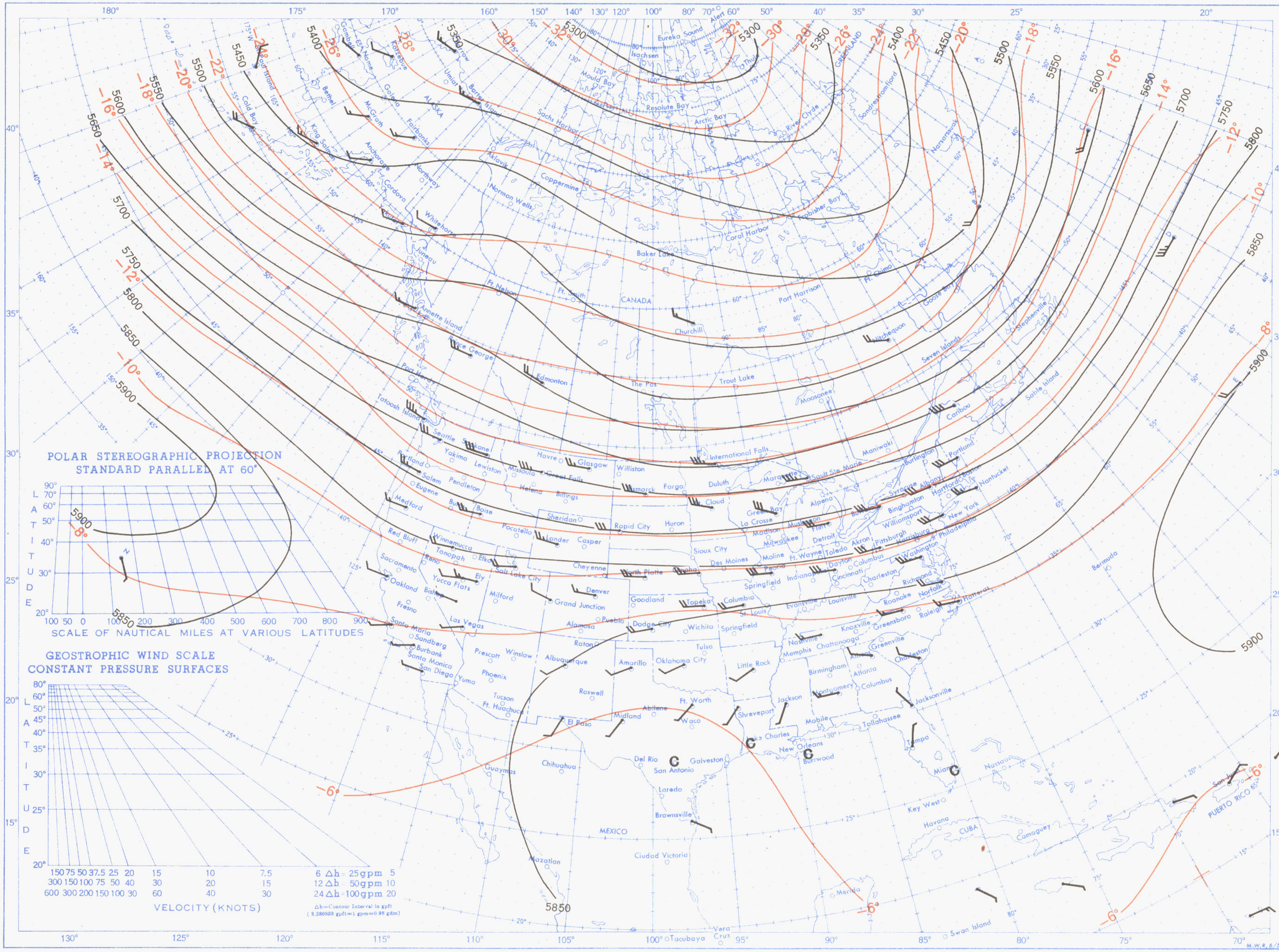
Height in geopotential meters (1 g.p.m. = 0.98 dynamic meters). Temperature in °C. Wind speed in knots; flag represents 50 knots, full feather 10 knots, and half feather 5 knots. All wind data are based on rawin observations.

Chart XIII. 700-mb. Surface, 1200 GMT, September 1958. Average Height and Temperature, and Resultant Winds.



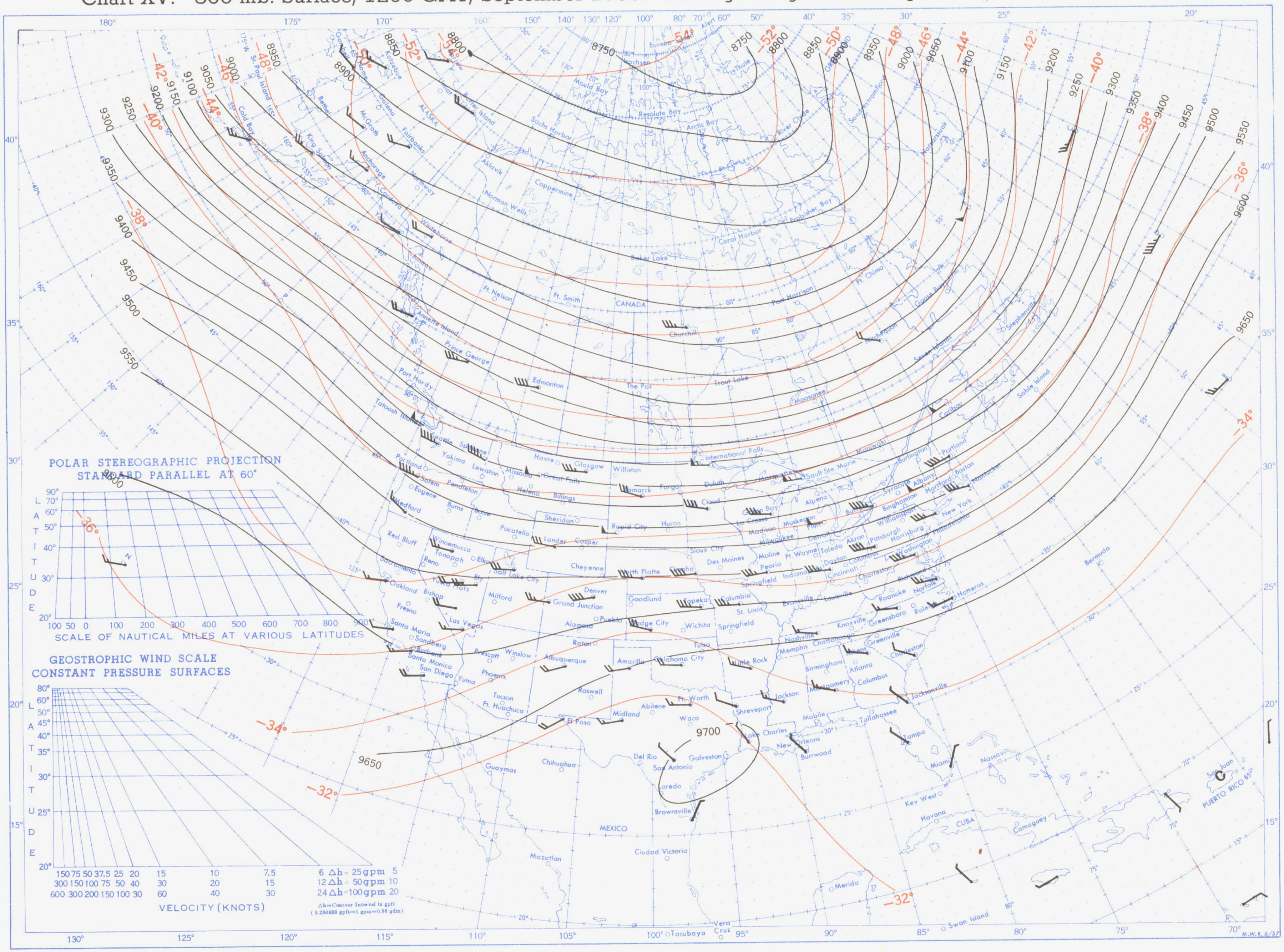
See Chart XII for explanation of map.

Chart XIV. 500-mb. Surface, 1200 GMT, September 1958. Average Height and Temperature, and Resultant Winds.



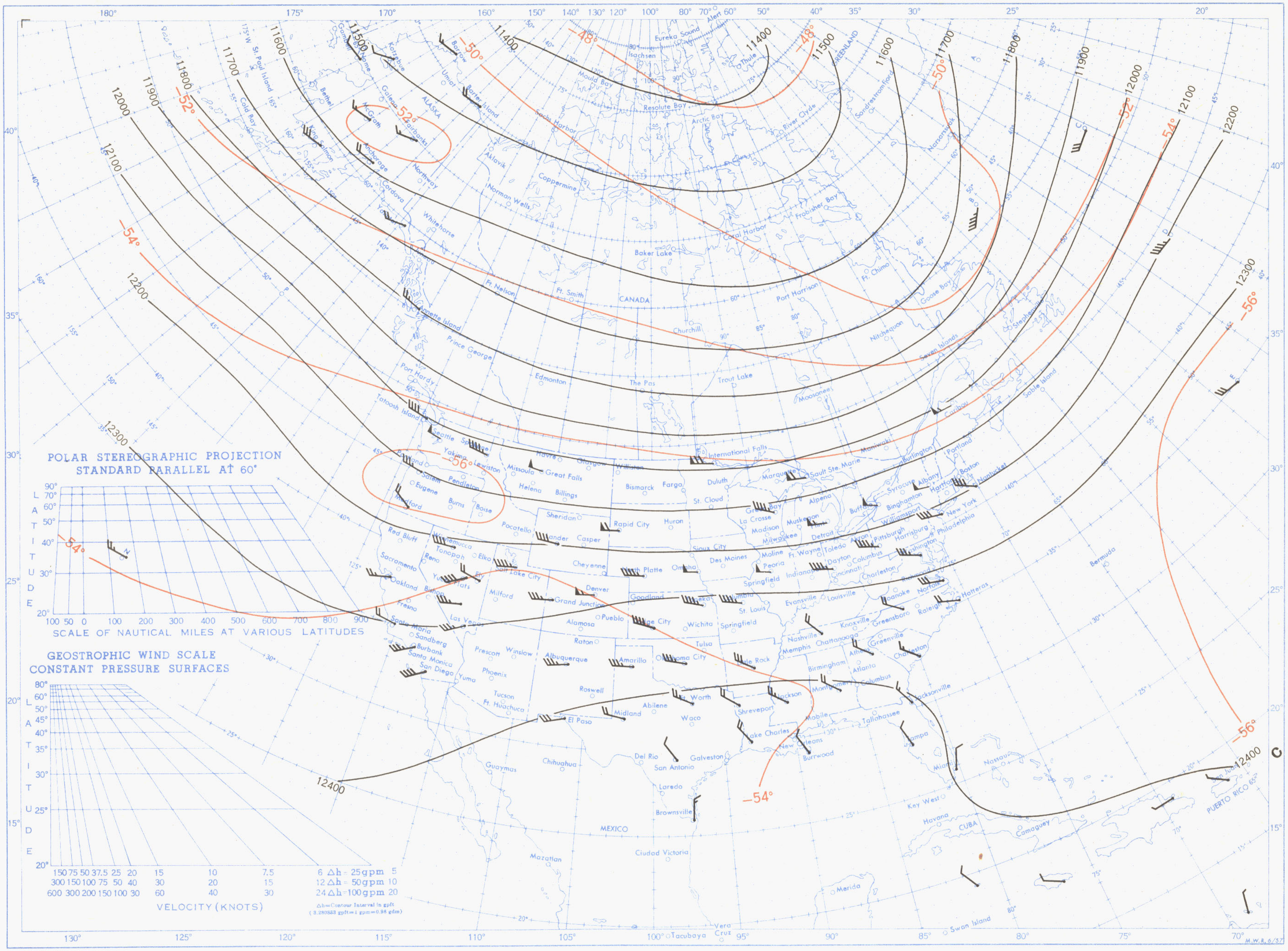
See Chart XII for explanation of map.

Chart XV. 300-mb. Surface, 1200 GMT, September 1958. Average Height and Temperature, and Resultant Winds.



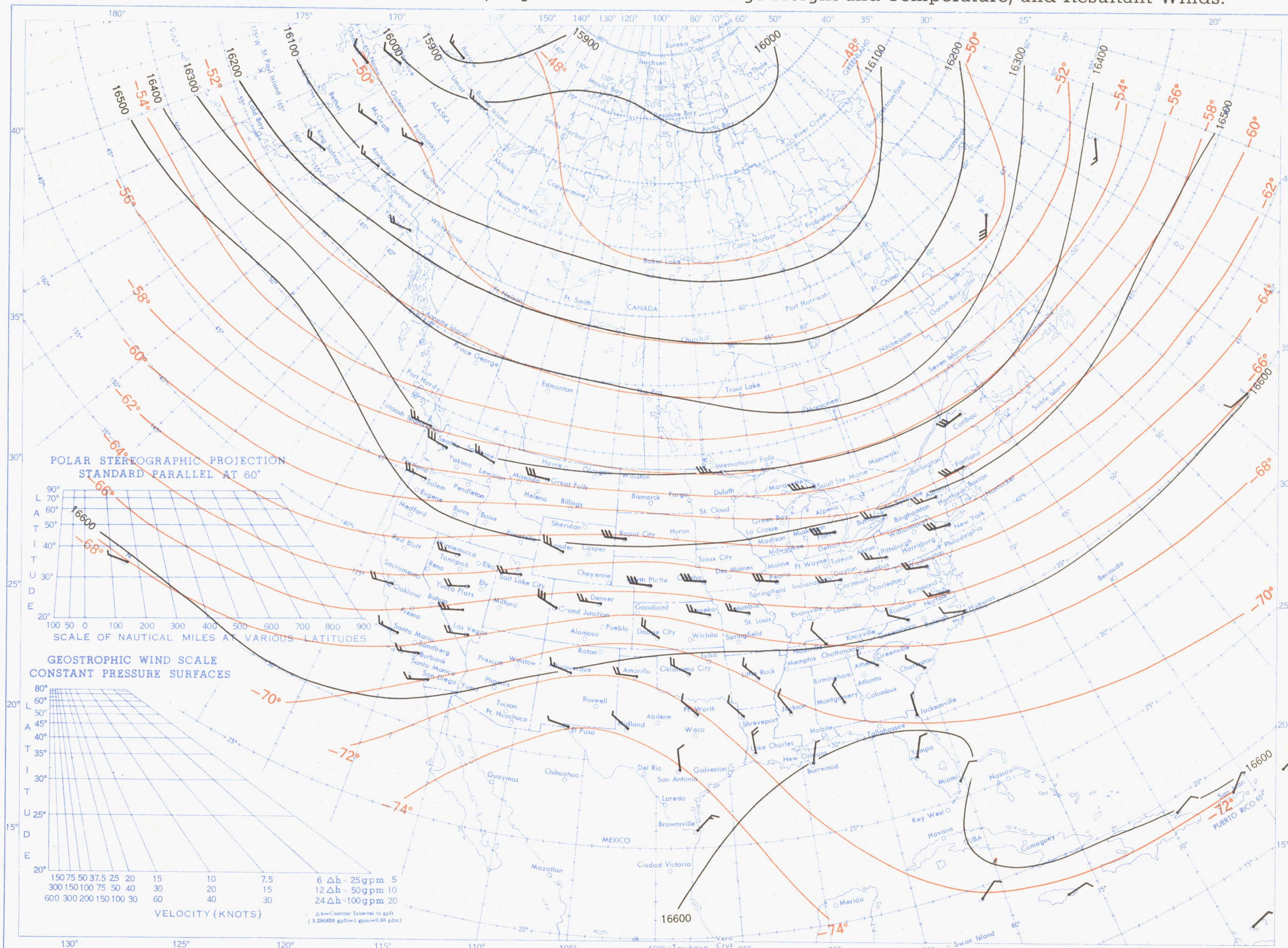
See Chart XII for explanation of map.

Chart XVI. 200-mb. Surface, 1200 GMT, September 1958. Average Height and Temperature, and Resultant Winds.



See Chart XII for explanation of map.

Chart XVII. 100-mb. Surface, 1200 GMT, September 1958. Average Height and Temperature, and Resultant Winds.



See Chart XII for explanation of map.